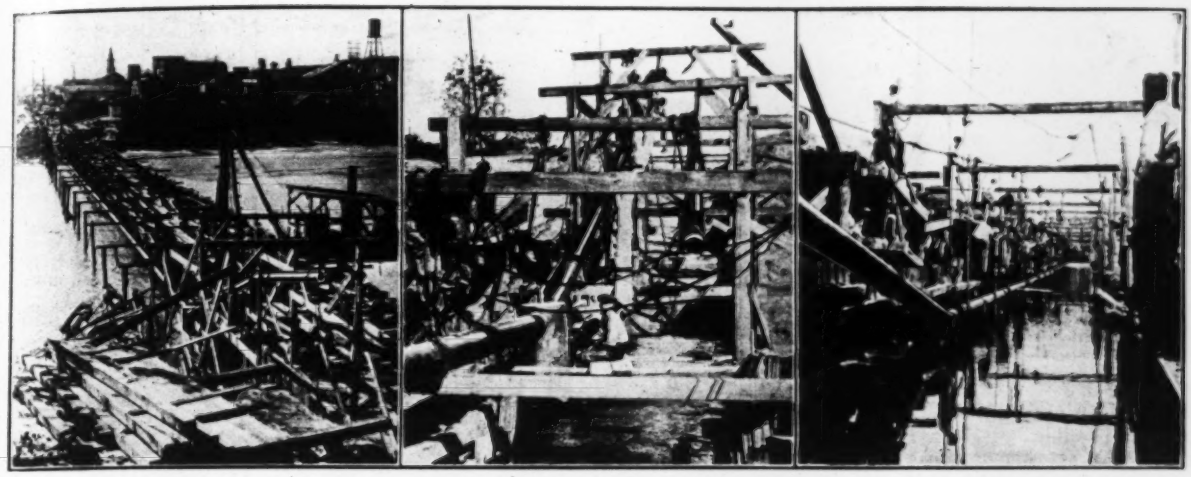


FIGS. 1 TO 3. PUTTING A 10-IN. GAS MAIN UNDER THE BRAZOS RIVER AT WACO, TEX.
Fig. 1—General view of falsework and suspended main. Fig. 2—Finishing drip pocket at shore end of first line; pipe ready to drop. Fig. 3—Welded pipe floating

beveled-end pipe had not been ordered, a butt-weld was necessary, the pipes being set 3/8-in. apart and the space filled with Norway iron. About 45 min. was required for each joint, compared with 30 min. for work where beveled ends have been used. The joints were first tested by bending, placing a block underneath and a man on each end; then the pipes were put under 90-lb. pressure.

After the 100-ft. lengths of the subaqueous section (550 ft. in all) of the first line were completed, they were pulled out over the river on the falsework for the final welds, which were rushed through. The welder was followed by a man coating the pipe with asphalt. Then burlap strips were wound on and coated with asphalt. A final layer of burlap and coat of asphalt were added.

Cast-iron drip pockets were ordered, but on receipt proved to be porous, so that new pockets were made of boiler-plate sheets welded up on the spot by the oxyacetylene equipment. The pockets were 24 in. in diameter and 5½ ft. high.

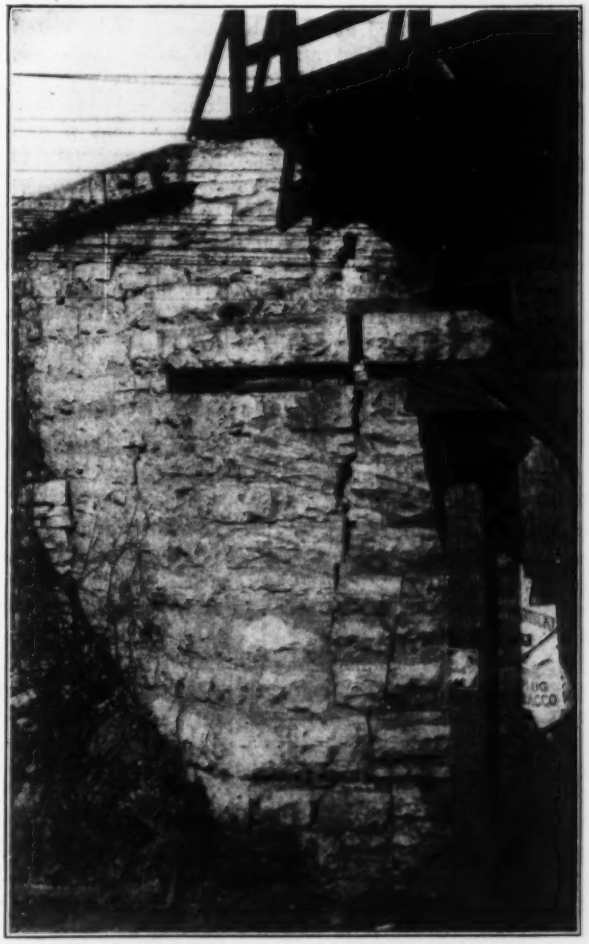
The line was lowered by block and tackle until it floated on the water inside the falsework. Then the pipe was loaded with 115 lb. of steel sheetpiling on each 20-ft. section to sink it into place. This entire procedure was repeated for the second main, and the electric cables were pulled across.

The total cost of the welding for this job is estimated at $650, including the services of one skilled welder for the equivalent of 38 days at $5.60 per day, the man's expenses, 3,600 cu.ft. of oxygen and 3,400 cu.ft. of acetylene—both at 2c. per cu.ft. The work was done under contract by the Phœnix Construction Co., of New York City, B. Diem, engineer in charge.

Fractured Bridge Abutment

The masonry bridge abutment shown in the accompanying view is on the Rock Island Lines at Newton, Iowa, the plate-girder bridge carrying the tracks over the main road approaching the station. The abutment is of stone masonry, of U-shape, and is cracked in both the main wall and the wing wall, the cracks being in line with the backs of the walls. The widest crack is in the main wall.

This is one of a number of similar abutments built 30 or more years ago. Several of these have cracked in the same way, though as a rule only one crack occurs (either in the main wall or wing wall), this being always in line with the back of the other wall.



MASONRY BRIDGE ABUTMENT CRACKED THROUGH MAIN WALL AND WING WALL

How To Store Cement

By S. P. Baird*

It is sometimes thought that only one thing is necessary for the safe and effective storage of cement—a tight roof. Many years' experience has convinced the writer that water-tight storage is not enough, and he has formulated the following principles for cement storage:

1. Cement will retain its strength for an indefinite period when stored in air-tight containers.

2. Cement will be injured less by storing in paper sacks than in cloth sacks, everything else being equal.

3. Cement in any kind of commercial packages will be injured least while in storage if the packages are piled as closely together as possible. In other words, the outside surface of the pile of sacks should be the smallest amount possible.

4. Piles of cement sacks should be covered with a tarpaulin to prevent as far as possible the circulation of air through the pile.

Note the word "tarpaulin"; an ordinary canvas cover is not a tarpaulin, but a paulin. Five parts coal tar, one part gasoline and one part good japan drier make a water-tight black coating for canvas.

Surface condensation often takes place on a stored sack of cement. The moisture is carried into the cement to its very great injury as well as the practical destruction of the sack. The destruction of the sack may not be evidenced at once; but it may be returned to the mill and refilled and sent to some other job, where it bursts and is paid for by a person who was in no way responsible for its condition.

There is a saying among cement men that if you turn your cement—that is, move it from one pile to another—once a month, it will not be injured by an indefinite period of storage. This is not the case; pile it closely and cover it as nearly air-tight as possible and you will have very little caked cement. If the cement is caked it is better to let it alone until you are ready to use it rather than break the cake, thus presenting fresh cement to the action of the air.

Subaqueous-Tunnel Record

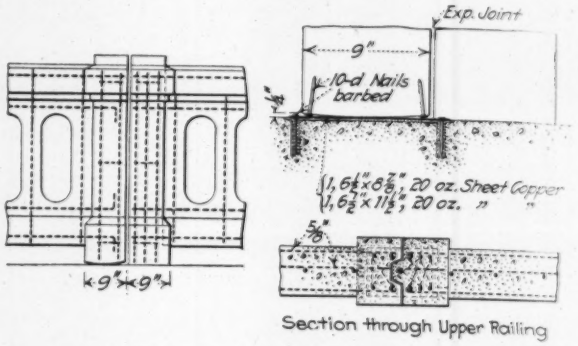
Rapid advance was made in driving the Dorchester rapid-transit tunnels under Fort Point Channel, Boston, Mass. The best month's run in one tube was 375 ft. of completed tunnel. A. A. Cahill discusses the progress of this contract in the May *Journal* of the Boston Society of Civil Engineers. The average run for the best three months was 325 ft. per month, a large portion of this being in hardpan. Mr. Cahill claims that this establishes a record for subaqueous tunnel driving. All spoil had to be brought through the shield and out of the locks.

No provisions were made for cooling the air when the air pressure was first placed on the tunnels, which was early in June, 1915. Shortly afterward, however, after-coolers were installed. The design chosen was 3 ft. in diameter by 12 ft. long, with about one hundred and twenty 1½-in. brass tubes, through which harbor water was pumped. Air from the compressor passes into the after-cooler, where it is cooled, expanded and then carried on to the heading through an 8-in. steel pipe.

*Engineer and Contractor, 315 Ninth Ave., Columbus, Ohio.

Expansion Bearing for Concrete Bridge Railing

In some of the reinforced-concrete bridges recently built by the City of St. Louis, Mo., the expansion in the railing is taken care of by the special joint shown in the accompanying drawing. The railing is of reinforced concrete, with longitudinally reinforced upper



EXPANSION BEARING ON BRIDGE RAILING FOR ST. LOUIS BRIDGES

and lower rails spanning between posts and a panel with close-spaced openings. At the expansion joint the post is split vertically and the bottom of the movable half is provided with a curved base sheathed with copper, which slides on a base plate of copper embedded in the sidewalk slab. The design was made by C. R. Martin, under L. R. Bowen, Bridge Engineer.

Staking Out Retaining Walls on Curved Alignment

By Livingston Leeds*

In staking out on steep slopes a curved retaining wall with a batter on the face, it is often troublesome to secure good alignment for the top, especially when the foundation depths vary and the top is on a grade. The curves

*Assistant Engineer, New York State Highway Department, 321 St. Nicholas Ave., New York City.

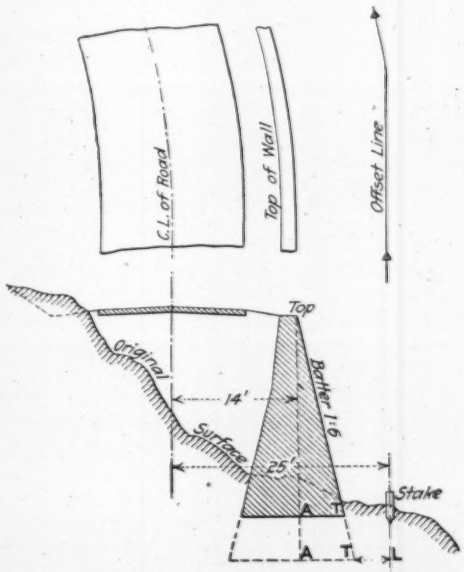
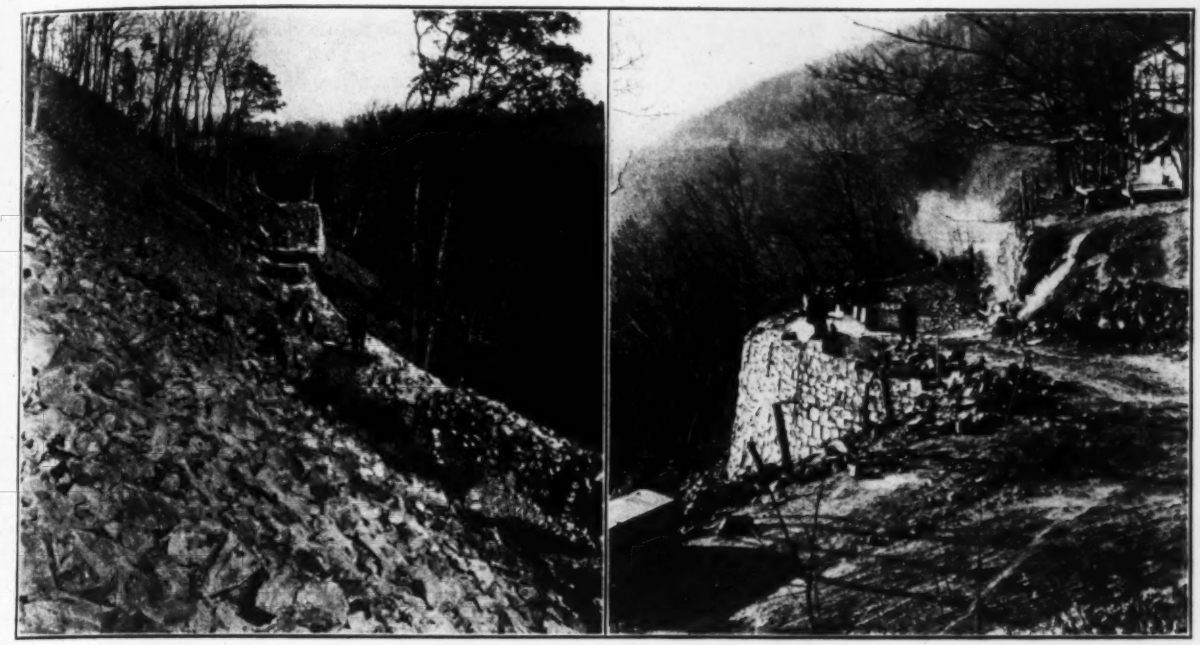


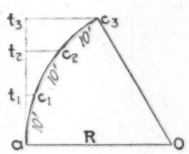
FIG. 1. LOCATING TOE OF WALL FROM OFFSET LINE



FIGS. 2 AND 3. CURVED RETAINING-WALL WORK ON A ROAD IN THE HUDSON HIGHLANDS

OFFSETS FOR SHORT-RADIUS CURVES, 10-FT. CHORDS

No. of Chords	R = 80 Ft. at	R = 80 Ft. te	R = 85 Ft. at	R = 85 Ft. te	R = 90 Ft. at	R = 90 Ft. te	R = 95 Ft. at	R = 95 Ft. te	R = 100 Ft. at	R = 100 Ft. te	R = 105 Ft. at	R = 105 Ft. te	R = 110 Ft. at	R = 110 Ft. te	R = 120 Ft. at	R = 120 Ft. te	R = 130 Ft. at	R = 130 Ft. te	R = 140 Ft. at	R = 140 Ft. te	R = 150 Ft. at	R = 150 Ft. te
1	9.98	0.63	9.98	0.59	9.98	0.56	9.99	0.53	9.99	0.50	9.99	0.48	9.99	0.45	9.99	0.42	9.99	0.38	9.99	0.36	9.99	0.33
2	19.80	2.49	19.83	2.34	19.85	2.22	19.86	2.10	19.88	1.99	19.89	1.90	19.90	1.81	19.91	1.66	19.23	1.54	19.94	1.43	19.95	1.33
3	29.32	5.57	29.40	5.24	29.46	4.96	29.52	4.70	29.56	4.47	29.60	4.26	29.64	4.07	29.70	3.73	29.74	3.45	29.78	3.20	29.81	2.99
4	38.38	9.81	38.56	9.25	38.71	8.75	38.85	8.30	38.96	7.90	39.05	7.53	39.14	7.20	39.27	6.61	39.38	6.11	39.47	5.68	39.54	5.30
5	46.83	15.14	47.19	14.30	47.49	13.55	47.74	12.87	47.96	12.25	48.15	11.69	48.31	11.18	48.58	10.27	48.79	9.50	48.95	8.84	49.09	8.26
6	54.56	21.49	55.17	20.33	55.68	19.29	56.11	18.34	56.49	17.48	56.81	16.69	57.09	15.97	57.55	14.70	57.91	13.61	58.19	12.67	58.43	11.84
7	61.43	28.76	62.38	27.26	63.18	25.90	63.86	24.67	64.45	23.53	64.95	22.50	65.39	21.54	66.11	19.86	66.68	18.40	67.13	17.15	67.50	16.04
8	67.35	36.82	68.73	34.99	69.90	33.30	70.91	31.77	71.76	30.35	72.50	29.05	73.15	27.85	74.22	25.71	75.06	23.86	75.73	22.25	76.28	20.84
9	72.21	45.56	74.13	43.40	75.76	41.41	77.16	39.57	78.36	37.86	79.40	36.29	80.31	34.83	81.81	32.22	83.00	29.95	83.94	27.96	84.72	26.21
10	75.94	54.84	78.50	52.40	80.68	50.11	82.56	47.99	84.18	46.00	85.58	44.16	86.81	42.43	88.84	39.34	90.44	36.62	91.73	34.23	92.78	32.12
11	78.49	64.51	81.78	61.84	84.61	59.31	87.05	56.93	89.15	54.67	90.98	52.57	92.59	50.59	95.24	47.01	97.35	43.85	99.04	41.05	100.42	38.57
12					87.50	68.88	90.57	66.29	93.23	63.80	95.55	61.47	97.60	59.25	100.99	55.20	103.69	51.58	105.85	48.37	107.63	45.81
13					89.30	78.72	93.08	75.96	96.38	73.29	99.26	70.75	101.81	68.32	106.04	63.83	109.41	59.79	112.12	56.16	114.35	52.91
14							94.57	85.85	98.57	83.05	102.06	80.35	105.17	77.74	110.34	72.86	114.48	68.40	117.82	64.38	120.57	60.74
15													107.67	87.42	113.89	82.21	118.88	77.39	122.92	72.98	126.25	68.97



are best laid out by means of offsets. One important advantage of the method in such rough country as shown in the views is that no transit is required.

The retaining walls shown—on the Nyack-Rockland Lake road now under construction by New York State—were laid out quickly and easily by measurements from an offset line carried along near the toe. The method is indicated in Fig. 1. The fieldbook procedure is to compute elevations of top of wall at the required stations and the distances AT (Fig. 1) from toe of wall to vertical line through top of wall, for the height of wall likely to be required. As soon as the trench has been carried to proper foundation stratum, the elevation of the bottom of trench is found by level, and the height of wall is obtained by subtracting from elevation of top of wall. The distance AT is then read from the table of these distances in the fieldbook, and the distance TL, giving location of toe from offset line, can be computed. This gives the necessary data for erecting the batter boards with the required slope.

To get the initial distance AL on curved alignment, a table of tangent distances and offsets will be found useful. The table given herewith covers the principal range of radii used in sharply curving road alignment.

Safety Device on Hoists Used on Foundation Wells

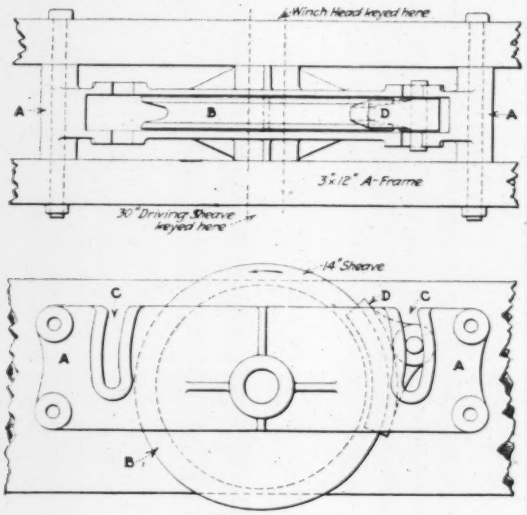
A safety device or grip for the hoists used extensively in Chicago for sinking foundation shafts or wells is shown in the accompanying illustration. The hoist consists of an A-frame or tripod with cross-timbers carrying a shaft that has at one end a winch head for the bucket rope and at the other end a 30-in. grooved sheave for the wire driving cable. This latter is an endless cable and serves a number of hoists in series. Should the cable break or leave the sheave, a bucket might overhaul or reverse the hoist and drop upon the men in the shaft. The safety device prevents this reverse movement.

Between the timbers of the headframe is bolted a casting A, which takes the place of the usual separator blocks; and within this runs a 14-in. grooved sheave or brake wheel B, which is keyed to the shaft. The casting has curved slots C, which are eccentric to the shaft. In these rest the ends of a short shaft carrying a grip or brake shoe D, which engages the groove of the sheave. When the sheave is running in its normal direction, as shown by the arrow, it tends to raise the shoe and thus keep it away from the groove, with very little friction.

If the driving cable breaks or comes off the 30-in. wheel and the bucket in the well starts to fall by overhauling the hoist, the friction from the reversed brake

sheave *B* forces the shoe downward. Its eccentric movement then causes it to jam this sheave so that the hoist shaft cannot revolve. Tests made with the device have shown that a 1-in. drop of the bucket is sufficient to apply the grip and prevent further movement.

Should the hoisting grip be so placed that the motion is in the reverse direction from that shown by the arrow,



AUTOMATIC SAFETY DEVICE FOR FOUNDATION HOISTS

the shoe would be lifted out of its seat and fitted to the similar curved slots at the other end of the casting. The device is made by French & Allen, manufacturers of contractors' equipment, 506 South Canal St., Chicago.

State Engineer's Office in Senate Chamber

The State Engineer of Arizona probably has the most "classy" drafting room to be found in the public service. A soft green plush carpet to tread upon and oil paintings to delight the eye are a few of the auxiliaries. This room, shown in the accompanying illustration, is the august senate chamber of the Arizona legislature in the state capitol at Phœnix.

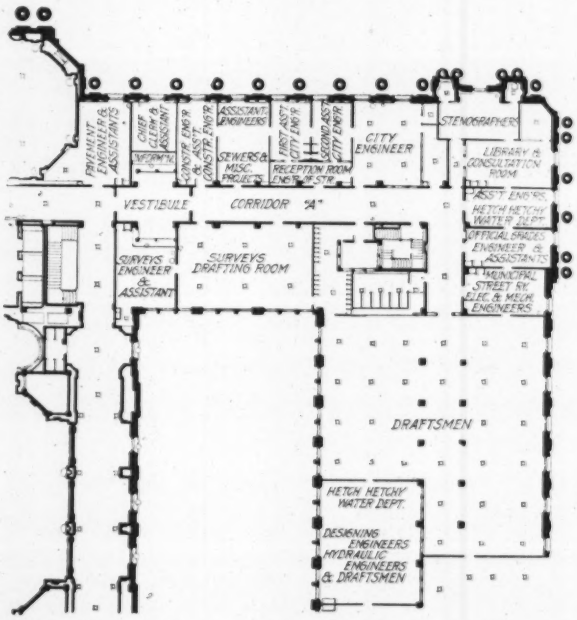
"DRAFTING ROOM" OF THE STATE ENGINEER OF ARIZONA

Fortunately, the legislature meets only biennially, so the room has to be vacated by the state's useful employees only occasionally. The state engineer's office proper is a modest room adjoining the senate chamber, but his private office between sessions is the office of the president of the senate at the right-hand side of the rostrum. The State Engineer is Lamar Cobb.

City Engineer's Offices, San Francisco

The city engineer's offices of San Francisco, now presided over by M. M. O'Shaughnessy, are arranged as shown by the accompanying plan. Like the other offices in the new city hall, these are equipped with the most recent type of devices for convenience and efficiency.

Approaching the department along corridor *A*, the visitor first passes through an outer door into a large public vestibule. At one side is the information counter,



ARRANGEMENT OF CITY ENGINEER'S OFFICES, NEW CITY HALL, SAN FRANCISCO, CALIF.

served by a chief clerk and assistant; on the other the survey counter, where the engineer of surveys and his assistants transact their business with the public. The pavement engineer and his assistants are accessible at the information counter, so that a large volume of business can be disposed of without admitting the public past the entrance vestibule. Beyond is the corridor leading to the offices of the various department heads and the city engineer. No one is allowed to enter this corridor or the offices adjacent to it except by direction of the chief clerk or his assistant.

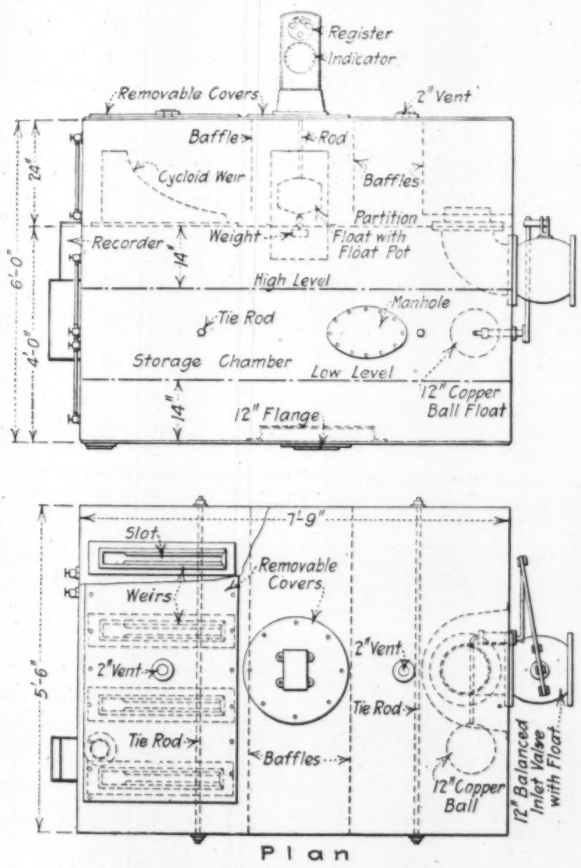
A dictograph system provides for direct intercommunication between all offices of the department. The offices of the city engineer, first and second assistants are furnished with master dictograph stations connected with all offices and drafting rooms of the engineering department and also with the mayor, city attorney, commissioners of public works, accounting department and cashier.

Cycloidal-Weir Water Meter in Power Plant

For measuring the water used at the power plant of the Minneapolis General Electric Co., at Minneapolis, Minn., a Kennicott cycloidal-weir meter has been installed, having a capacity of 1,200 gal. (or 10,000 lb.) per min. The device consists of a steel tank divided into two parts by a horizontal partition. The water is delivered to the upper compartment, which has baffle plates to check eddying, and a float to operate the register and indicator.

Upon the partition are four weirs, which are narrow upright boxes, having one side shaped to a cycloidal curve and with the slot or orifice in the curved face. With this arrangement the flow of water through the weir is directly proportional to the head above the weir at any stage of water level in the compartment. The meter is reported to register the weight of water within 1½% of the exact flow; this presumes the meter to be adjusted to the actual water temperature.

The water passing through the curved weir slots falls into the lower or storage compartment. An indicator



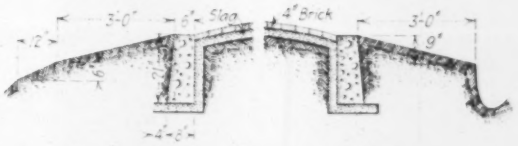
CYCLOIDAL-WEIR METER OF 72,000 GAL. PER HR. CAPACITY

shows the rate of flow, and a register shows the total amount of water that has passed through the meter. A recording gage or chart may also be applied. This water measuring device was built by the Kennicott Co., Chicago Heights, Ill., which owns the patents on the cycloidal weir. H. M. Byllesby & Co., Chicago, are consulting engineers for the power plant.

Slag Base for Brick Roads in Pennsylvania

Brick roads in Westmoreland County, Penn., are built as shown in the sketch. Prior to May 11 either stone or slag was specified for the base, but since that date slag alone is called for. The slag is obtained both from the Carnegie Steel plant and from the railroad.

On the slag base rolled to a thickness of 6 in., an inch of sand is placed. On this are laid the bricks, which



CROSS-SECTION OF TYPICAL BRICK ROAD (SLAG BASE) BUILT IN WESTMORELAND COUNTY, PENN.

are bought from kilns in the general vicinity. At the present time five sections of roads are under contract, aggregating 8.25 mi.

Greensburg—the county seat of Westmoreland—also is building some brick roads of this familiar construction. Before rolling, the slag is 12 in. thick; afterward 6 in. A sand cushion 2 in. thick is specified, but rarely attained in practice, the object being merely to even the slag bed. Last season Greensburg paid $1.34 per sq.yd. (exclusive of excavation) and $0.44 for the excavation, which is done by hand.

NOTES

A Handy Tool For Blasters has been invented but not patented by Carl D. Livingston of the College of Agriculture of the University of Wisconsin. It is a combination fuse cutter, cap crimper and fuse slitter all in one. Many serious accidents have happened from rough or flattened fuse ends, which make it necessary to twist the fuse into the cap with more or less force. A clean cut, square cap end is always desirable, because the cap will not stand careless treatment without danger of exploding. The new tool is shaped like a pair of pruning shears and has an adjustable blade which can be sharpened. Firm, smooth, and tight connections between fuse and cap are obtained by means of a special crimping device, placed directly under the pin. The slitting device is on the end of the cutting blade.—"Wisconsin News Bulletin."

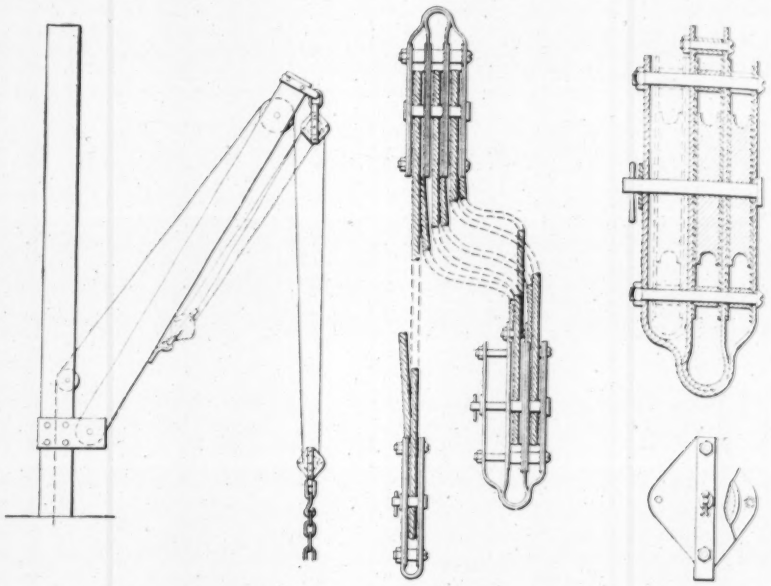
Protecting Auburn's Water-Supply—In making daily inspections, during the year 1915, to protect the purity of the water-supply of Auburn, N. Y., drawn from Lake Owasco, the inspectors of the Auburn Water Department traveled 4,070 mi. by train, 2,500 mi. by motorcycle, 500 mi. by horse and wagon, 317 mi. by automobile and 54 mi. by boat, besides walking 2,633 mi.—which doubtless seemed more than all the rest put together. By means of this total of over 10,000 mi. of travel 27,535 inspections were made, 470 written notices for violation of rules and regulations were served, and several thousand copies of the water-supply rules were distributed to campers and owners along the lake shores. All this work was done in accordance with the provisions of rules and regulations for the State Department of Health to protect the water-supply of the City of Auburn, in accordance with Sec. 71 of the Public Health Law of New York. To keep tab on the character of the water coming down from Lake Owasco for the city, 637 bacteriological examinations were made. Gas-producing bacteria were found in 88 of the samples. The water was treated with liquid chlorine for a total of 195 days during the year. For a greater part of the time the bacterial count determines whether or not chlorine shall be used, but during portions of the year chlorine is used regardless of the count. J. Walter Ackerman is engineer and superintendent of the Auburn water-works.

Cargo Weighed Graphically—The displacement method of determining the weight of cargoes of stone is described as follows by A. S. Ackerman in the May "Journal" of the Boston Society of Civil Engineers:

The draft marks of a vessel are taken at the stem and stern loaded and again when lightened and pumped out. In the latter condition the vessel is measured, an operation which occupies about an hour, after men have become accustomed to taking measurements. The length is taken horizontally on deck, forward of the after part of the stern post, which is called station zero, to a point just forward of the loaded mark on the cutwater, the length being divided into stations of 10 ft., and at the bow, sometimes, of 5 ft. At these stations the semi-widths are obtained to the outer edge of the rail, and then at each succeeding station offsets from a plumb line hung from the rail by means of an outrigged stick so that the line just touches the side of the hull at the widest part of the section, are taken to the side of the hull at each even foot above light water-line, the plumb line being tagged every foot. These measurements are taken as carefully as possible horizontally and normal to the axis of the vessel; and the distance subtracted from the semi-width at the rail plus the distance to the plumb line from the outer ends of the rail gives the semi-width of the vessel at each even foot plane above light water-line for each station. After measurements are taken at all stations, the slant of the cutwater and sternpost is obtained in the same manner. Each station section taken as above is blotted on cross-section paper and a mold of the hull at that station for the distance displaced. From these sections distances are taken and a horizontal section of the hull plotted for each foot above light water-line. These areas are then planimetered and the volume for each foot computed and plotted as a curve. In determining the cargo carried by a vessel, the mean of the bow and stern displacements is read off the curve, giving the tons directly. In computing the weight, that of sea water is assumed as 64.2 lb. per cu.ft., and tons are obtained in units of 2,000 lb.

Well Points and Triplex Pumps Drain Quicksand—The accompanying illustrations show in use part of an installation of one hundred 1½x36-in. No. 60 well points used by James Ferry & Sons, of Atlantic City, for unwatering a sewer trench that ran through a bed of quicksand. On previous jobs in this locality the trench has caved and sand has flowed even from back to the curb and sidewalk. The normal water level is between 2 and 3 ft. below the surface, but by working the pumps only continuously it is held down to 12 to 15 ft. below. Two complete outfits have been provided, each comprising 100 well points, 100 six-foot lengths of rubber hose, 100 valved T-connections, about 600 ft. of suction main and a 7x8-in. Goulds triplex pump (5-in. suction and discharge) belted to a 7½-hp. electric motor and having a capacity of 200 gal. per min. Motor and pump were set up in a portable shed.

Reducing the Parts of a Hoisting Line to two without extensive change of tackle is the purpose of an invention just announced by C. M. Seacombe, 259 West 34th St., New York City. The sketches explain the scheme. It is of service on jobs where there are light pieces to be hoisted, as well as heavy, or for assorting and setting steel (using 2-part line) after it has been hoisted by a 4- or 6-part line. A very similar device was employed by the American Bridge Co. in erecting the Hell Gate arch for the New York Connecting R.R.



HOW TO MAKE A MONKEY PURCHASE (TWO PARTS) OUT OF A MANY-PART HOISTING LINE IN A FEW MINUTES

Gravel Ballast under the old specifications of the American Railway Engineering Association is allowed 30 to 35% of sand, but the Ballast Committee considers that further specifications should be made as to the proportions of material of different sizes. Tests of actual ballast on different railways showed proportions (by weight) of wide variation, as follows: Passing ⅛-in. screen, 0.6 to 43.4%; retained on ⅛-in., 2.4 to 48.6%; retained on ¼-in., 15 to 37.6%; retained on ½-in., 12 to 64%; retained on 1 in., 4.3 to 13.2%. The committee has pointed out that the efficiency of gravel for ballast is much improved by washing.

WELL POINTS AND TRIPLEX PUMPS USED TO DRAIN ATLANTIC CITY QUICKSAND

Editorials

Long-Term Water-Works Bonds

The experience of water-works engineers with longer-lived equipment than found in most other public utilities evidently inclines their minds toward longer-term bonds than are now customary in financing water-works projects. The thoughtful article by Mr. Butcher, printed elsewhere in this issue, is only one of the multiplying evidences of this feeling. It is possible that the accumulated experience of water-works may warrant some extension of present bond terms, but such a move should be very cautiously made and with due regard for the "public policy" which conscientious officials use as the excuse for shortening terms.

One reason for maintaining no longer bond terms than now prevailing, prominent just now but not discussed by Mr. Butcher, is the risk of obsolescence. It avails nothing if the apparatus be physically long lived, if it becomes inadequate, antiquated or uneconomical. There are numerous cases where cast-iron mains still good for long years of service have been discarded because of the need for larger pipe or different sources of supply. In other instances old reciprocating pumps, in good repair and running at nearly original duty, have been replaced by high-speed centrifugals.

We do not know the conditions under which the next generation of engineers and financiers must work, and therefore we should endeavor so far as possible to preserve for them a balance of liabilities equal only to the unimpaired physical assets. Lengthening the term of bonds tends away from that end and is not to be done without the most careful deliberation.

After all, it is barely possible that undue worry is caused over this quick redemption of bonds. If the bonds are paid off, the public as a whole cannot have that amount of principal in private service and paying private dividends; but if the bonds are not paid, roughly the same sacrifice is required—since the public pays the interest on the bonds. All in all, then, a cautious public policy is a proper ideal.

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Popularizing Water Meters

That there is a deep-seated prejudice against water meters in the popular mind every water-works superintendent knows only too well. An important part of his job is to dispel the prejudice by substituting information for ignorance. That done, he has gone more than half way in converting wholesale opposition to meters into a general demand. He cannot expect to jump that far at one leap. Instead, he may have to be thankful if he makes an occasional convert to the use of meters. To keep doing this water-works officials must conduct a never-ceasing campaign of education and interest.

There are various ways of creating a popular demand for meters. The thing of fundamental importance is to establish meter rates and rules that will be their own argument for selling water by meter instead of by guess.

With this as a solid foundation a campaign of publicity is imperative. There are various ways of conducting such a campaign. One that has been tried effectively to further the use of water as well as of water meters is use of the advertising pages of the local press. Efforts of this kind best known among the water-works fraternity are probably those conducted for some years past at Terre Haute, Ind., and noted more than once in the columns of *Engineering News*. Elsewhere in this issue there are reproduced a number of advertisements of water and water meters that have been run in the local papers at San Antonio, Tex.

It is significant that the water-works at both Terre Haute and San Antonio are owned by private companies. How many other companies push the sale of water and the demand for water meters by advertising is unknown. Some, doubtless, but comparatively few, it seems. Probably very few do it so effectively as the two companies mentioned.

Would it be against good public policy for municipally owned works to advertise in like manner? Whatever the answer, probably it could rarely be done without going to the legislature for authority. Lacking authority, or deeming it not good policy for a municipality to promote the sale of water or the use of meters by advertising, other effective, if not equally effective, ways of popularizing water meters could doubtless be found by wideawake municipal water-works officials. Where there's a will there's a way! Who will lead? Who is already in the lead, but too modest heretofore to make it known?

⁂

Firestopping as a Safeguard for the Wooden House

There is something new under the sun occasionally. A modest book of a hundred pages or so, just issued, belongs in the distinguished class of new things. Addressing itself to every homebuilder, it tells him, to his great advantage, certain vital matters that he could not learn before this. It gives him advice on how to make his wooden house safe by firestopping.

Firestopping is by this book developed comprehensively into an art, or a science. In fact the art is newly created. Rudiments of it have existed, but even in this form it was nowhere recorded. Gathering together the elements of present practice, and rounding them out into a complete art by study and redesigning on the basis of modern fire-protection science, the authors of the book have created something radically new.

It is true, firestopping is only one of ten or eleven chapters in the book. It is also true that the book has much to say on houses with masonry walls, houses with concrete floors or incombustible partitions and other rare features. But the vital portion is that which bears in a practical way on the thousands and thousands of dwelling-houses built every day—the wooden houses—and shows how a little care, and perhaps a very few dollars added, will make them vastly safer against fire ruin.

Two chapters besides the one mentioned have the same extensive interest and value; in fact they belong under the same head of firestopping. They deal with the roof and the cellar, and their aim is to show how the main body of the house may be cut off from the hazards above and the hazards below. The cellar ceiling and the roof and eave structures, being the lower and upper terminals of the firestopping system, are integral parts of that system.

The National Board of Fire Underwriters, whose engineers and fire experts wrote the book, publishes it under the title "Dwelling Houses; a Code of Suggestions for Construction and Fire Protection," and plans to distribute it free. For the price of mailing, ten cents, a copy will be sent to whoever asks for it. More copies may be had, for the cost of the express charges. Such openhanded gratuitous distribution represents a gift to the public that is remarkable in its importance. It is greatly to be hoped that the public will respond in a proportionate degree, by studying and using the treatise.

If we mistake not, Ira H. Woolson pulled the laboring oar in the preparation of the book, and correspondingly deserves chief credit for the new technical achievement. But whoever may be responsible for the work, congratulations are due on the successful result. The book marks an epoch in building practice.

Government and Student Free Engineering Service

Kentucky is the latest center of agitation over free engineering service in alleged unfair competition with engineers who, however much they would like to serve the public without charge, are yet forced to depend upon fees for a living. A letter published elsewhere in this issue raises questions regarding the action of the United States Public Health Service in responding to a request from the City of Lexington, Ky., for advice regarding the advisability of going into a scheme for treating sewage by an electrolytic method, the city already having in hand a report by a firm of consulting engineers recommending an entirely different scheme of sewage disposal.

A second letter, also published elsewhere in this issue, calls attention to a notice which appears to have been published generally in the city press of Kentucky offering the services of senior engineering students in the University of Kentucky for the preparation of plans and specifications for water-supply and sewerage systems, the work to be done under the direction of the Dean of the Civil Engineering Department.

On first thought it will very likely seem to the majority of practicing engineers that in each case the rendering of gratuitous service in the way specified is an unpardonable injustice to members of the engineering profession. The matter, however, is not quite so clear and simple as appears on the surface, especially as regards the advice sought of and given by the United States Public Health Service.

Taking up that case first, the well put statement of the Public Health Service side of the case made by Surgeon-General Rupert Blue should be considered. The gist of this is that the Service prepares no plans and has nothing to do with construction. It may be explained further, a fact not brought out in the correspondence and only hinted at in the opening paragraph of this note, that substantially all that the Public Health Service investigation and report covered was whether the report and plans already before the City Council when promoters of a proprietary scheme appeared upon the scene were well suited to solve the Lexington sewage-disposal problem. If it be asserted that even this was a matter which should have been left for some consulting engineer in regular practice to settle, then it may be replied that city councils have not yet reached such a state of perfection and have not yet attained such confidence in consulting engineers serving for pay as to make these officials always feel that they can satisfy their own consciences and perchance the clamors of the public by relying implicitly upon paid engineers. The city authorities of Lexington doubtless considered, and considered rightly, that they could get disinterested advice from the United States Public Health Service.

After all that has been said, however, there still does remain a basis for questioning whether the United States Public Health Service is justified in undertaking to respond to such a call as came from Lexington, even though it had, as Surgeon-General Blue says, been some time engaged in studying water-supply and sewage disposal at Lexington in connection with a general investigation of stream pollution. The question is a part of the far larger one as to the proper delimitation of the functions of Federal, state and local authorities, in health and in other matters.

Coming now to the question of the free engineering services by students from the University of Kentucky there may first be considered the argument for the offer evidently conceived by many higher institutions of learning. This argument, as it runs in the minds of many, is that a university supported by the state owes a duty to the state and its various divisions which goes beyond that merely of giving instruction. The argument runs, further, that many of the communities of the state, at least the smaller and more backward ones, would go for years without proper engineering or other technical or professional advice before they would sufficiently recognize its worth to bring in and pay for the services of an engineer or other professional man. Some of these places, however, will accept an offer from a state university or engineering or other school supported by state funds (and perhaps they would not stick at whether the financial support was public or private) to have a preliminary investigation and more or less complete plans and estimates made for public improvements. Such plans and estimates having been made, and for that matter in the very making arouse public attention to the advantages and finally convince the citizens of the necessity of the improvement. Meanwhile, it is urged, students have been getting the benefit of practical experience that they could not otherwise obtain while in school.

A far more serious question than the effect on the profession is the character of the service likely to be rendered under conditions of either free Federal aid or free assistance by engineering students. In saying this, we are not questioning the advice given by the United States Public Health Service in the particular case in hand. As a general proposition, however, the various branches of the Federal government are not sufficiently well manned either in numbers or professional competence of the majority of such staff as exists to

make proper studies of local questions, determine all the various facts based upon local conditions, and then give advice—much less prepare plans and specifications—that will meet the needs of the case.

The chances of getting proper service from engineering students are of course slimmer than for getting it from Federal bureaus. Of course the only hope for reliable work in the case of students is the direction that can be given them by their engineering professors or instructors. It might be argued that when the students reach the close of their senior year they are as competent to go out and work under the direction of a professor as they would be to step into an engineering office or field party and work under the direction of an engineer or private contractor. To a large extent this is true, but to how large an extent?

The whole matter is many sided, beset with difficulties, and probably will not be settled definitely for some time to come. Meanwhile it is well to remember that it is not merely a bread-and-butter affair, but one involving service to the public by Federal and state governments and institutions supported by public funds.

Centralized Municipal Shops

The fine new central repair-shop and storage-warehouse plant of the City of Chicago, described elsewhere in this issue, calls attention to a notable development which is growing in importance all over the country. New York City has just established a Department of Plant and Structures to replace the Department of Bridges and to operate consolidated repair shops for all boroughs and all departments (as noted in *Engineering News*, Apr. 13, 1916). This will save a million dollars a year. On the Pacific Coast, San Diego has such a central shop, and Los Angeles seems to be approaching it with its water-works repair plant.

This commendable movement is only a logical development of municipal government previously paralleled in the history of most public utilities and many industrial concerns. It is one of the economies and refinements that comes as a city approaches its final status and overcomes the handicaps of pioneer days which make any maintenance of adequate fire, police, water and sewer services difficult, to say nothing of economical.

Forests and Rainfall Again

Dr. Nicholas Murray Butler, President of Columbia University, before the recent annual meeting of Associated Press representatives in New York, made an eloquent appeal for national unity, which deserves and has received wide attention and commendation. There is one passage in Doctor Butler's fine address that deserves a word of comment in these columns. We quote as follows:

> **We must remember that the greatest empires have fallen as well as risen. There is no reason to suppose that our America is going to escape the everlasting law of change. Who can predict how many hundreds or thousands of years it will take before the forests will be felled, and the streams will be dried, and this great fertile continent of ours, like the plains of ancient Iran, where civilization began, will become a desert fit only for surveying parties of the archæologists?**

The theory that rainfall and stream flow are dependent upon the existence of forests and that it is the removal of the forests which has caused parts of Asia Minor and China to become arid deserts, was given wide publicity by the Government Forest Service some ten years ago. Notwithstanding the repeated demonstrations by engineers of the fallacy of this theory, evidence recurs every little while of the extent to which the theory has taken hold of popular imagination. The prominence given to this theory in President Butler's notable address makes it worth while again to call attention to its fallacy. Some of the other causes well set forth in the speech may conceivably reduce the United States to desolation, but he can be assured that no matter how much the forests may be depleted during hundreds or thousands of years, their removal will not make this fertile continent a desert.

More Facts About Concrete

Because design requirements dictate the fixing of unit stresses in concrete more or less unrelated to conditions of manufacture, there has arisen a tendency to regard such artificial standards as immutable and to assume that a concrete which varies considerably from the set average is peculiar and abnormal. Those concerned with the testing of materials, however, are not so chained to the average as is the designer and they are not so apt to consider the nature of concrete an open book. This is fortunate for the designer, because the scientific curiosity of the tester is constantly revealing new facts and upsetting old theories.

While possibly no very radical discoveries nor startling upsets can be found in the latest concrete report of the United States Bureau of Standards, noted on another page, it is a fact that that report contains more complete and succinct information on the compressive strength of concrete than has ever been gathered together in one volume. It is, in stock phrase, a veritable mine of facts. Many of the current controversies may be settled by reference to its pages, many faults in practice might be cured by following its lessons. The space at the command of a periodical does not permit more extended reference to the tests than is given elsewhere, but we can heartily commend its study to all concrete practitioners.

Twenty-Eight Millions of Work for One Contractor

The fascination of large contract figures is supplemented, in the case of a remarkable record made during the week just past, by the separate fascination of the difficult nature of the work. Securing a paltry 2½ million dollar contract last Thursday, the Flinn-O'Rourke Co. piled up the prodigious total of $28,000,000 worth of tunnel and subway contracts in New York City. The chief item in the list is a group of six subaqueous tunnels—three sets of two each. These are all under the East River, and they possess every bit of the difficulty and danger that everywhere characterize tunnel-driving in loose river bottoms.

In this large program of work that the above figures represent a dozen tunneling shields have already been starting and are pushing forward, most of them with the help of compressed air. Eight more are to be erected soon, to drive the pair of tunnels at Fourteenth St.

There has been no prior case of 20 shields working simultaneously under one contractor's direction and on the same enterprise.

Letters to the Editor

Panama Canal an Unprofitable Business Enterprise

Sir—Six years ago, in your issue of Feb. 10, 1910, you were kind enough to print a letter from me criticizing the economic aspect of the Panama Canal undertaking. In the editorial comment appended to that letter, the military rather than the commercial advantages of the canal were emphasized. Since then the canal has been actually completed and opened to traffic, and the greatest war of history has come on and still rages. Actual war has shown how slight is the advantage of a few warships more or less and how serious is the economic strain of a great war under modern conditions.

To return to the writer's protest against unsound economic action by this nation, it is unfortunately the case that the nation's expenditure on the Panama Canal is taken as a precedent and a yardstick by which to justify other proposed national expenditures, as for instance national highways, drainage projects, waterway improvements, ship subsidies, ship construction, etc. The canal passed 6½ million tons of shipping in the first year of its operation (Prof. Emory R. Johnson predicted it would have 10½ million tons that year). For months and months of its second year it was blocked by the slides; and now, according to the testimony before the Interstate Commerce Commission on Apr. 24, the managers of the principal steamship lines which ply from coast to coast say they will not resume traffic by this route for one to two years, and possibly longer. Meanwhile interest on the nearly $400,000,000 that the canal has cost goes steadily on.

In conclusion, my argument as to what can be justifiably spent now for future benefits, as contained in my article of February, 1910, and based on A. M. Wellington's line of reasoning, has lost none of its force from what has since come to pass. A. P. C.

Nashville, Tenn., May 4, 1916.

Cost of Utility Changes Made To Avoid Interferences

Sir—The article on "Cost of Utility Changes Made To Avoid Interferences," in *Engineering News*, Mar. 23, 1916, gives no reason why the method advocated is theoretically correct. The matters discussed are becoming daily of greater importance, so that the writer has judged a further attempt to elucidate the proper theory to be of interest and service to utility engineers.

Any attempt to analyze the question of charges in such cases must involve a large number of assumptions. The influence of many of these assumptions on the final cost will, however, be so small that they may be neglected or considered to balance one another. For the sake of clearness the corporation in prior occupancy of the street will hereafter be spoken of as the company, and the person or corporation desiring to have the changes made will be referred to as the contractor.

Clearly, the company is entitled to demand that the work shall be done at no cost to it and that its property on completion of the work shall be of the same value for its purposes that it was before the changes. The value to any public-service corporation of any portion of its plant at any time may be divided into the revenue-producing value, present and prospective, and the present worth of the recovery value at the end of its useful life. The revenue-producing value may be thought of as a capitalization of the revenue earned by the plant unit in question. This revenue will ordinarily be sufficient to cover all annual and maintenance charges on the unit, including the amortization, within the useful life of the unit, of the difference between the cost of installation and the recovery value. The recovery value may be defined as the difference between the cost of removal and the value of the recovered unit for re-use or as junk. In the case of plant that cannot be abandoned when no longer useful this recovery value may be either a liability or an asset.

The present worth of this future recovery value is the sum which, if invested or borrowed (as the case may be) at the present time, would at the end of the useful life of the unit amount to its recovery value.

All jobs involving the replacement of existing plant units with new units result in a theoretical benefit due to the increased life and a theoretical detriment due to working on existing plant. Since both of these are vague quantities and may never be realized in actual practice, it will in most cases involve no appreciable error to assume that they balance each other and therefore to neglect them. If the work is done by the company, the cost of financing the changes until the bill is rendered and paid should, if considered at all, be added to the bill as a certain percentage or as a fixed sum and should not be confused with the material and labor costs of doing the work.

In each of the cases considered, except that in which a unit is replaced with one of larger capacity, it is assumed that the revenue-producing values of the old and new units are the same. This may be made clear for the case of a unit replaced with one of smaller capacity by a consideration of the following example: A factory, surrounded by homes of the employees, in an outlying section is burned and is not to be rebuilt. Most of the houses are therefore abandoned. The value to the company of the plant installed to care for this locality is then its greatly reduced revenue-producing value plus the present worth of its recovery value at the end of its useful life. Plant of smaller capacity would evidently have the same revenue-producing value.

In all cases in which the revenue-producing value remains the same the value to the company of the plant removed should be compensated for by the contractor as follows: The revenue-producing value by the installation of new plant of an equal revenue-producing value; the present worth of the future recovery value by (1) the equal present worth of the future recovery value of

the new plant installed or (2) the present worth of the future recovery value of the new plant, together with a cash adjustment of the difference between this amount and what would have been the present worth of the future recovery value of the old plant if no changes had been made. The company is thus fully compensated for the value of all plant removed and can have no claim on the material recovered in connection with the work.

When a unit is replaced with a unit of larger capacity, the contractor should pay the cost of replacement with a unit of equal capacity; and all material recovered should be credited to the contractor. The company thus receives equal revenue-producing value and present worth of future recovery value at the contractor's expense. The company secures at its own expense the additional revenue-producing value and present worth of future recovery value of the larger unit by paying the extra cost due to replacement with the larger unit. The rule for all cases is therefore as follows:

Charge the contractor for all material, labor, supervision, etc., for the change. Credit the contractor with all material recovered. Charge the contractor an amount equal to the present worth of the future recovery value of the old plant if no change had been made. (This will be a credit if the recovery value is a liability.) Credit the contractor with an amount equal to the present worth of the future recovery value of the new plant. (This will be a charge if the recovery value is a liability.) When the new unit is of larger capacity than the old, these rules apply to amounts not exceeding the charges and credits for a unit of the same capacity, since that is the extent of the contractor's responsibility.

This differs from the rule given in the article under discussion in that the latter gives to the company the present value of the recovered unit for re-use or as junk, with no charge for removal, instead of the present worth of the future recovery value, which was defined as taking account of the cost of removal. The company would thus make a profit on the job, amounting to the cost of removal of the old unit plus the difference between its present recovery value and the present worth of its future recovery value. If a profit is to be made, it should not be confused with the accounting charges in this manner and probably should not be a function of the time the plant is to remain in service.

DWIGHT F. NORTON.

227 Gates Ave., Brooklyn, N. Y., Apr. 4, 1916.

Effect of Stream Turbulence on Current Meters

Sir—It has for some years been known that measurements of flow in pipes, conduits, etc., determined by indications of the velocity head with pitot tubes or venturi tubes frequently gave over-registration when the rate of discharge was subject to great and frequent fluctuations. As far as the writer knows, no satisfactory explanation of these phenomena has been made. Apparently, rotary meters of the paddle-wheel type are subject to the same difficulty to a much greater extent, and the fundamental cause may be the same.

In the case of the measurement of a stream with a current meter a simple explanation may be that, where the velocity varies, the rotating parts of the meter will be subjected to different impulses in the same direction. Those greater than the average will impress upon the meter a velocity which it will retain until friction reduces it to the average velocity, so that the tendency must be for this reason to over-register. Obviously, the more mass in the rotating parts the greater will be its effect. The only remedy would seem to be to make the rotating parts of the meter as light as possible, say of aluminum.

The writer has every reason to believe that in a turbulent stream the measurement with a standard current meter might be from 15 to 50% high on this account, while if the same meter were rated in water of a constant velocity, it would show perfect accuracy. The effect is about the same as if a meter were given an initial velocity before being placed in the water, and while in that position every impulse greater than the average would have the same effect.

The matter is of great importance, because many of the rating tables prepared by the Government are based on current-meter measurements for streams whose flows are subject to large fluctuations.

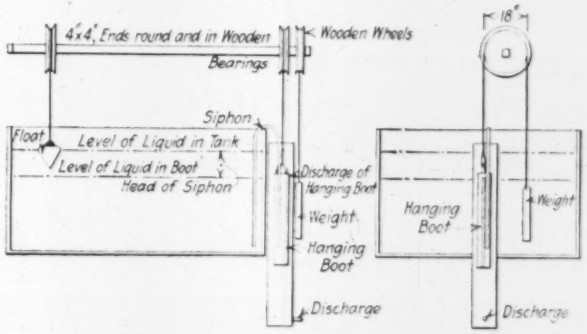
J. W. LEDOUX.

112 North Broad St., Philadelphia, May 6, 1916.

Constant-Flow Device

Sir—In *Engineering News*, Apr. 27, 1916, I note an article by Mr. Westen Gavett, describing a device to give constant flow of liquid. I inclose a sketch of the device used by me for some years to give constant flow of acid on our Glover and Gay Lussac towers.

It consists of a 4x4-in. timber, the ends turned round and mounted in wooden bearings above the supply tank. Spiked on this are three wooden wheels—each made of a circle of a 2-in. plank, with a 1-in. circle on each side, nailed with the grain at right angles to that of the 2-in., and forming a rim. From the first of these wheels



CONSTANT-FLOW SIPHON

hangs a float, resting in the liquid of the supply tank. From the second wheel hangs a boot by means of a chain threaded through the handle. In the end of the chain is a hook which fastens into a link of the chain, and enables the boot to be raised or lowered. This boot has a discharge near the top, and empties into a discharge box surrounding it, with its opening near the bottom. The third wheel carries a weight balancing the boot and float. A siphon is set with one leg in the liquid of the supply tank and the other in the hanging boot. The head of this siphon, and therefore its flow, is controlled by lowering or raising the hanging boot; and once set, the head and discharge remain constant, for float and boot rise and lower with liquid of the supply tank. For use with acid the tank is lined with lead.

A handy man can build and set up this device in a very short time and at a small expense.

ISAAC C. BREWER.

Civil Engineer; Superintendent Jarecki Chemical Co.

Sandusky, Ohio, May 3, 1916.

Federal Public Health Service as Consulting Engineers

Sir—Herewith is a report upon the sewage-disposal project of Lexington, Ky., made by the United States Public Health Service, acting apparently in the capacity of consulting engineers. If such gratuitous reports should be recognized as proper, then consulting engineers who have made a life study of sewage disposal and looked to such appointments for their livelihood must ultimately seek other occupations.

ALEXANDER POTTER.

50 Church St., New York City, Apr. 15, 1916.

[Mr. Potter's letter has been submitted to the United States Public Health Service. A reply, from Surgeon-General Blue, is appended. Some comment on the questions raised appears on the editorial pages of this issue.—Editor.]

Sir—I beg leave to acknowledge the receipt of your letter of the 17th instant, inclosing copy of a communication received by you from Alexander Potter, in which he questions the propriety of the Federal Government investigating and reporting on the sewage problems of municipalities.

In reply you are informed that on requests of states and municipalities investigations are undertaken from time to time to stimulate improved methods of sewage disposal in the interest of the public health. These studies do not involve the preparation of particular plans, however, nor the supervision of construction. Oftentimes failure to respond to requests to make such studies would operate to prevent indefinitely any improvements contemplated. The relation borne by the service to the authorities previously mentioned, therefore, is one of helpful coöperation and of advantage to the engineering profession generally.

In the particular instance referred to in your communication service officers had been studying sewage and water problems of Lexington for some time in connection with general investigations of pollution of streams, and the city authorities had also previously employed engineers to go over the local situation and advise them.

RUPERT BLUE,
Surgeon-General.

Bureau of Public Health Service, Washington, D. C., Apr. 19, 1916.

Student Engineers Offered to Kentucky Cities in May

Sir—Herewith is a clipping from the Lexington, Ky., *Leader* of Apr. 11, 1916, which is of interest in connection with the question of student employment in competition with practicing engineers.

While it may be true that the work Professor Rowe and his student engineers do would not seriously embarrass any practicing engineer, it does mean that the value of engineering service is minimized in the eyes of the public; and the profession is, to that extent, injured when advice is offered on "a something for nothing" basis.

In this particular instance Professor Rowe is freely offering "complete plans and specifications and estimates for water and sewers in such form that they may be used in part or entirety." After such a proposition from the dean of the civil-engineering department of the state university, it will doubtless be difficult to convince a city council to employ an engineer who charges real money for his services.

I am told that this notice has not only appeared in the Lexington papers, but has also been given some publicity throughout Kentucky.

G. R. SOLOMON.

Atlanta, Ga., Apr. 15, 1916.

[The clipping from Mr. Solomon reads as follows:

In an endeavor to coöperate in the movement to better the sanitary conditions of towns and cities of Kentucky, the College of Civil Engineering of the University of Kentucky will offer the services of its senior students during May to complete plans, specifications and estimates of building proper sewage and water-supply systems of the cities in such form that they may be used in part or carried out in entirety whenever the municipal authorities order it to be done. The students will spend a month in the field, taking field notes and accumulating the data needed for the drafts and plans. The work is under the supervision of Prof. Walter E. Rowe, dean of the civil-engineering department of the university. Professor Rowe will visit the scenes of activity of the young engineers and give instruction and outline the work to be done.

Comment on this subject may be found on the editorial pages of this issue.—Editor.]

Turneaure's Impact Formula Too Complex

Sir—The impact formula given on p. 286 of your issue of Mar. 30,

$$K = \frac{1}{1 + \frac{L^2}{30{,}000}}$$

if adopted universally might serve as an unfortunate example of the use of empiric data.

The Rankine column formula has been largely abandoned in favor of straight-line formulas because its increased accuracy is not worth the extra labor of using it mentally, and looking up values in tables is annoying. Type of floor and ratio of dead- and live-load stresses affect impact as well as loaded length, and an impact formula which considers only one factor should be so simple that it can be applied mentally.

The values of $K = 100 - \frac{1}{4} L$, with minimum of 15, can be computed at sight without using the slide-rule. Comparing with the other:

Span, ft.	0	25	50	75	100	150	200	300	400	500	600
First formula	100	98	92	84	75	57	43	25	16	11	8
$100 - \frac{1}{4} L$	100	94	88	81	75	62	50	25	15	15	15

For the chord members of a 200-ft. span having a live-load stress of 100, the dead-load stress might reach 50 and the total stress by the two formulas would be 193 and 200 respectively. The difference is 3½%. For a 600-ft. span the percentage of difference would be less. The errors in the usual methods of design for ordinary cases are considerably larger than 3½%.

The writer of course does not presume to criticize Prof. Turneaure's work, nor is he competent to propose new impact formulas. He simply wishes to point out that often very simple expressions may be found to represent the results of complicated observations with an accuracy quite sufficient for all practical purposes.

C. T. BRADY, JR.

544 Bartolomé Mitre, Buenos Aires, Argentina, Apr. 26, 1916.

North Carolina Has 3,800- and 4,200-Ft. Cableways

The world's longest cableways have recently been installed by the Champion Lumber Co., at Sunburst and Crestmont, N. C.—having reaches of 3,800 and 4,200 ft. respectively. These are not cableways of the types commonly employed in engineering construction, being logging skidways, but they are all the more of interest to engineers and contractors. This type of cableway was developed several years ago by J. H. Dickinson, Chief Engineer of the Logging Department of the Lidgerwood Manufacturing Co., New York City. It consists of (1) a steel head spar mounted, with engines, drums and accessories, on two steel railway cars, (2) a tail tree—which is only a sturdy tree in an advantageous location, stripped for blocks, and (3) the lines of cable swinging between.

The 4,200-ft. skidway, at Crestmont, has two clear spans—900 ft. from head spar to relay tower and 3,300 ft. from there to tail tree. The 3,800-ft. skidway, at Sunburst, has a single span, but the tail tree is 1,000 ft. higher in elevation than the head spar. In these two installations the head spar is a 75-ft. latticed steel mast, on trunnions for lowering ahead (when the logging operations require a new set up) and with a full swiveled base (the tail-tree block being shifted through any angle up to 360° for a single head-spar position).

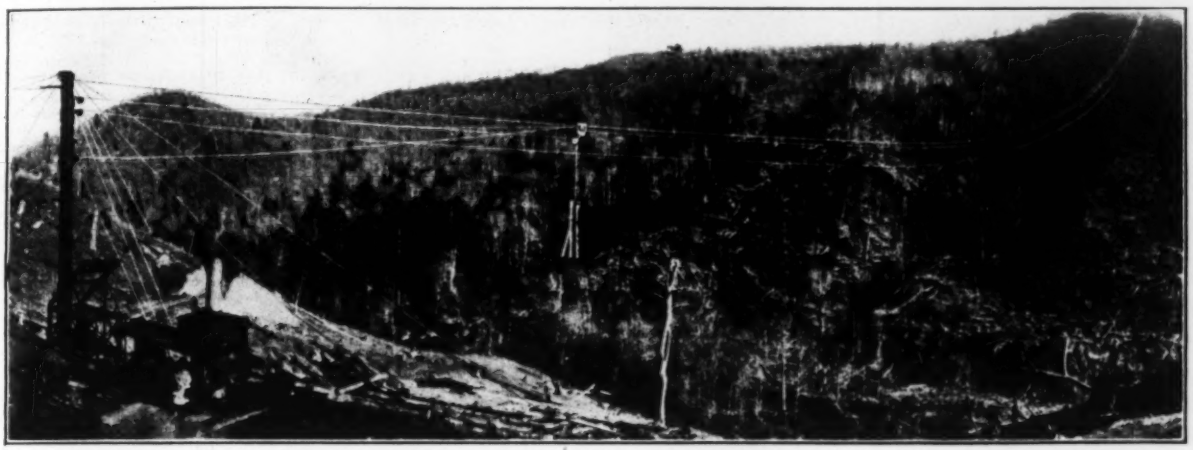


FIG. 1. LOGGING CABLEWAY WITH 3,800-FT. SPAN AT SUNBURST, N. C.

What is called the skidder car has a capacity of 100,000 lb. and carries, on two four-wheel standard-gage trucks, the boiler, skidding and reel engines, and an air compressor for the car brakes. The spar car is also mounted on two four-wheel trucks and carries the head spar and a utility engine for raising the spar. In changing a set-up two extra cars are placed ahead of the spar car—one to carry the spar and one as a spacer.

A 1½-in. cable is swung between the head spar and tail tree, at the spar coming down to a reeling hoist for hauling in or for changing the sag from time to time. On this cable runs a small carriage, as shown in the accompanying views. The skidding cable comes off the outhaul drum on the head-spar car, goes through a block on the spar, out through the carriage and the block on the tail tree, and back to the carriage. From the skidding drum a second cable goes up through a block on the spar and through a block suspended from the carriage. To take up the slack on the skidding line and to bring the end down to the ground (as there is no weight on the end before logs are picked up) a slack pulling cable is hitched to the skidding line, reeved through a sheave on the carriage, run back to a spar sheave and down to a slack-pulling drum. This rigging is shown in Figs. 1 and 2.

The three drums mentioned have slow-speed gears on their shafts, all geared to and driven by a low-speed pinion on the main power shaft. The skidding and outhaul drums are connected to these gears by standard cone friction clutches; the slack-pulling drum has an iron-to-iron floating friction. On the other end of the power and outhaul-drum shafts are a high-speed pinion and gear with a friction between the power shaft and pinion.

The operation of the skidway is as follows: On the outhaul the high-speed gear is used with the outhaul drum, pulling in the line at 2,900 ft. per min.; the skidding and slack-pulling drums are then overhauling. During the next step, the outhaul drum is held on brake while the slack-pulling line is hauled in—overhauling the skidding drum and bringing the end of the skid line to ground. On the third step, after the logs have been hitched on, the skidding drum inhauls at 900 ft. per min., the interlocked outhaul drum paying out its line at the same speed; the slack-pulling drum is overhauling under slight tension.

These cableways were selected by P. C. Thede, General Manager of the Champion Lumber Co., because of the growing difficulty with older equipment of supplying the company's mills with logs (these two mills having a combined capacity of 180,000,000 ft. per year—7.2% of the state's entire lumber production). The Crestmont holdings comprise 55,310 acres, and the Sunburst 35,124 acres. The estimated timber is 1,078,500,000 ft., log scale. The districts are mountainous and have been logged for 15 years, so that all the easily accessible stands have been cut. The best timber is now high up on the ridges untouched.

The character of the country was not such that a 4,000-ft. skidway could be used everywhere, but the saving in many of the set-ups (time lost in relaying track and moving is reduced some 75% over that of 1,500-ft.

FIG. 2. HEAD SPAR AND REEL CARS FOR 4,200-FT. SKIDWAY

cableways) made the largest machines desirable. The Lidgerwood company, which made the skidways, however, conservatively specified that they were to be two-span cableways with only 2,000 ft. per span. It is reported, by the lumber company, that logging with 3,800-ft. span costs less than with the old 1,500-ft. machines, because of greater skidding speed. With the two new high-speed machines and five old slow-speed 1,500-ft. units in operation, the total cost of logging has been reduced about 30c. per thousand.

Government Reports Elaborate Concrete Strength Data

As Technologic Paper No. 58, the United States Bureau of Standards, S. W. Stratton, Director, has just issued a most extensive resumé of the properties of concrete. The title of the bulletin is "Strength and Other Properties of Concretes as Affected by Materials and Methods of Preparation," and it has been prepared by Rudolph J. Wig, Engineer-Physicist, G. M. Williams, Assistant Engineer-Physicist, and E. R. Gates, Assistant Physicist, all of the Bureau. The book, which contains 172 pages, including 38 tables and 44 diagrams, may be obtained from the Bureau of Standards or the Superintendent of Documents, at Washington.

The data presented includes the results of some 20,000 tests. Compressive and tensile tests were made upon mortars at different ages, including about 240 different sands and stone screenings, and compressive tests were made on concretes composed of 60 aggregates, including limestones, gravels, granites, cinders and trap rock, as well as tests of the physical properties of the sands, stone screenings and coarse aggregates. These data furnish information on the range of strength values which were obtained with different aggregates in various consistencies, with variation in workmanship of fabrication, in the method of placing, and in subsequent exposure.

The results of such an elaborate series cannot be given here, but as an indication of the scope of the series there are appended here the conclusions arrived at by the authors. The tabulations and diagrams themselves form one of the most valuable contributions to the knowledge of concrete so far made public. The conclusions are as follows:

PORTLAND CEMENT MORTAR MIXTURES

Sand as a type of fine aggregate cannot be said to be superior to limestone screenings.

The proper gradation of the fine aggregate for maximum strength in a mortar appears to vary for different materials.

The results of the tests of the mortars included in this paper would indicate that for most materials the highest strengths are obtained with those having a gradation of particles approaching a straight line. There are materials, however, having a gradation varying widely from a straight line, which give high strength in mortars.

The quality of a sand cannot be judged from its gradation alone. Any limitation arbitrarily placed upon the proportions of the particles of various sizes will probably eliminate some very satisfactory materials.

No fine aggregate should be rejected because of its "silt" content determined by washing or assuming the material passing the No. 200 sieve as silt, as it may be advantageous even in relatively large quantities or detrimental in small quantities, depending upon its form, character, and distribution.

Mortars having high density usually have high strength.

The quality of sands to be used in cement mortars cannot be determined from their "uniformity coefficients."

There is no difference in the strength developed by rounded and sharp-grained sands.

The quality of sands cannot be determined from their specific gravity and porosity.

Sands having a gradation approaching Fuller's curve for maximum density do not have as great strength as sands having a gradation approaching a straight line.

The only satisfactory method of determining the value of a fine aggregate in mortar mixtures is to test it in the mixture in the proportion to be used, exposed to the same conditions as in the proposed structure.

Common usage has demonstrated that certain sands are satisfactory and therefore no tests of these materials are necessary excepting to identify them.

The relative value of several fine aggregates to be used in concrete cannot be determined by testing them in mortar mixtures. They must be tested in the combined state with the coarse aggregate.

PORTLAND CEMENT CONCRETE MIXTURES

(A) Relation of Type of Aggregate to Compressive Strength—No type of gravel or stone aggregate can be said to be generally superior to any other type used as coarse aggregate in concrete mixtures. Certain limestones are superior to certain gravels, and some gravels are better than other limestones. The range of qualities in any of these types is very great and the strengths of concretes made up of several different materials of the same type may vary as much as several hundred per cent. with all other controllable factors uniform.

(B) Relation of Workmanship to Compressive Strength—Undoubtedly greater uniformity is generally obtained by machine mixing than by hand mixing. The method of mixing is of little importance so long as it results in a homogeneous mass. Using proper methods and with the expenditure of sufficient labor, results indicate that as good concrete can be obtained by hand mixing as by machine mixing, although it probably would not be economical.

With all other factors constant the results included in this paper show that differences in manipulation of the mixture by the workmen of several experienced concrete contractors may cause a maximum average variation in the compressive strength of the resulting concrete of 70% or more.

(C) Relation of Consistency of Mixture to Compressive Strength—The quantity of water added to the mixture in preparing concrete affects materially the compressive strength at all ages. With the proper quantity of water the strength may be several hundred per cent. greater than that obtained with a large excess of water.

The most satisfactory consistency from the standpoint of strength and durability is a quaking or mushy mixture, and the error should be on the side of using too little rather than too much water, providing it is properly spaded or worked into place in the forms. This statement does not apply to the very dry mixtures used in the manufacture of concrete blocks, etc. In the case of these products the mixture should contain the maximum quantity of water which will permit of the immediate removal of the molds. This latter mixture has less water than the quaking consistency described above.

(D) Relation of Density to Compressive Strength—With the same aggregates and the same proportion of cement to total volume of aggregate the mixture having the greatest density will have a high and usually the highest compressive strength.

Density is no criterion of compressive strength of two mixtures of an aggregate if the ratio of cement to total volume of aggregate is not the same.

Density is no criterion of compressive strength of two mixtures of the same proportions of cement to total aggregate if different aggregates are used, although when the aggregates are quite similar they may be comparable.

(E) Effect or Various Exposures on Compressive Strength—The character of the exposure of the concrete after molding materially affects its compressive strength. If the original water is permitted to evaporate from the concrete and all water is subsequently excluded, the compressive strength may be reduced 40% or more. Concrete should preferably be kept wet for several days or weeks after it is deposited if the maximum strength is to be attained.

(F) Effect of Exposure to Steam on Compressive Strength—Steam greatly accelerates the hardening process and will increase the strength of concrete only a few days old by several hundred per cent, depending on the temperature and duration of exposure.

(G) Relation of Gradation of Aggregate to Compressive Strength—There is no definite relation between the gradation of the aggregate and the compressive strength which is applicable to any considerable number of different aggregates.

The gradation curve for maximum compressive strength, which is usually the same as for maximum density, differs for each aggregate.

The so-called maximum density curve, which is a combination of the straight line and ellipse, does not represent the curve for maximum density excepting for the particular materials used in the tests from which it was derived, or very similar materials.

No equation for a gradation curve, which can be applied to a number of different aggregates, can be prepared from the results included in this paper.

Maximum density and maximum strength are usually obtained with a concrete in which the ratio of fine to coarse aggregate is not less than 1 to 3. This mixture is usually quite stiff and therefore more difficult to handle than a mixture containing a larger percentage of fine aggregate.

Excessive fineness does not necessarily result in a totally unsatisfactory sand for concrete. A seashore sand having 99% passing a 50-mesh sieve, when mixed with a good coarse aggregate and cement, was found to give a satisfactory concrete.

(H) Relation of Proportions to the Compressive Strength—With the relative volume of fine and coarse aggregates fixed the compressive strength of a concrete increases directly as the cement content but not in a proportionate ratio. An increase in the ratio of cement to total fine and coarse aggregates when the relative proportions of the latter are not fixed does not necessarily result in an increase in strength. For example, a concrete mixed in the proportion of 1 part cement to 9 or 10 parts of total fine and coarse aggregates combined so as to give a maximum density may have greater strength than a concrete mixed in the proportion of 1 part cement to 6 parts total of the same fine and coarse aggregates, which are not combined to give a maximum density.

GENERAL CONCLUSIONS FROM THE TESTS

1. No standard of compressive strength can be assumed or guaranteed for concrete of any particular proportions made with any aggregate unless all the factors entering into its fabrication are controlled.

2. A concrete having a desired compressive strength is not necessarily guaranteed by a specification requiring only the use of certain types of materials in stated proportions. Only a fractional part of the desired strength may be obtained unless other factors are controlled.

3. The compressive strength of a concrete is just as much dependent upon other factors, such as careful workmanship and the use of the proper quantity of water in mixing the concrete, as it is upon the use of the proper quantity of cement.

4. The compressive strength of concrete may be reduced by the use of an excess of water in mixing to a fractional part of that which it should attain with the same materials. Too much emphasis cannot be placed upon the injurious effect of the use of excessive quantities of water in mixing the concrete.

5. The compressive strength of concrete may be greatly reduced if, after fabrication, it is exposed to the sun and wind or in any relatively dry atmosphere in which it loses its moisture rapidly, even though suitable materials were used and proper methods of fabrication employed.

6. The relative compressive strength of concretes to be obtained from any given materials can be determined only by an actual test of those materials combined in a concrete.

7. Contrary to general practice and opinion the relative value of several fine aggregates to be used in concrete cannot be determined by testing them in mortar mixtures. They must be tested in the combined state with the coarse aggregate.

8. Contrary to general practice and opinion the relative value of several coarse aggregates to be used in concrete cannot be determined by testing them with a given sand in one arbitrarily selected proportion. They should be tested in such combination with the fine aggregate as will give maximum density, assuming the same ratio of cement to total combined aggregate in all cases.

9. No type of aggregate such as granite, gravel or limestone can be said to be generally superior to all other types. There are good and poor aggregates of each type.

10. By proper attention to methods of fabrication and curing, aggregates which appear inferior and may be available at the site of the work may give as high compressive strength in concrete as the best selected materials brought from a distance, when the latter are carelessly or improperly used.

11. Density is a good measure of the relative compressive strength of several different mixtures of the same aggregates with the same proportion of cement to total aggregate. The mixture having the highest density need not necessarily have the maximum strength, but it will have a relatively high strength.

12. Two concretes having the same density but composed of different aggregates may have widely different compressive strength.

13. There is no definite relation between the gradation of the aggregates and the compressive strength of the concrete which is applicable to any considerable number of different aggregates.

14. The gradation curve for maximum compressive strength, which is usually the same as for the maximum density, differs for each aggregate.

15. With the relative volumes of fine and coarse aggregate fixed, the compressive strength of a concrete increases directly, but not in a proportionate ratio as the cement content. An increase in the ratio of cement to total fine and coarse aggregates when the relative proportions of the latter are not fixed does not necessarily result in an increase in strength, but may give even a lower strength.

16. The compressive strength of concrete composed of given materials, combined in definite proportions and fabricated and exposed under given conditions can be determined only by testing the concrete actually prepared and treated in the prescribed manner.

17. The results included in this paper would indicate that the compressive strength of most concretes, as commercially made, can be increased 25 to 100% or more by employing rigid inspection which will insure proper methods of fabrication of the materials.

Bonds for Levee Construction to the amount of $1,500,000 have been voted by the St. Francis Levee Board, which is in charge of levee building in the St. Francis district of Arkansas near Memphis, Tenn. At the time of the passing of the vote the board thought that the Humphreys bill which recently passed the House of Representatives provided that levee districts and states should appropriate one-third of the amount appropriated by the government, and on that basis they announced that the $1,500,000 so obtained would be added to the $4,500,000 from the Federal government, giving $6,000,000, which would complete the 106 mi. of levee work, all of which would be at a height sufficient to stand the stage of 51 ft. at Memphis. The board then planned to issue one-third of the bonds immediately in order to secure $1,500,000 on the passage of the bill and two similar amounts to be secured as needed thereafter. The Humphreys bill passed the House of Representatives with a proviso that the districts and states should pay one-half of the Federal appropriation. The final outcome of the St. Francis situation depends on the passage of the bill in its completed state.

News of the Engineering World

St. Paul Starts Water-Works Improvement Program

As a start in the series of improvements to the water-works of St. Paul recommended by Allen Hazen, Consulting Engineer, New York City, in 1915, plans have been prepared and bids are to be received on June 5 for constructing two coagulating basins and a covered high-service reservoir. The coagulating basins will be used temporarily as a low-service reservoir. Contracts have already been let for a pumping plant which will deliver water to the high-service reservoir.

Mr. Hazen recommended the construction of a mechanical filtration plant including coagulation basins, a pure water reservoir, an aërator, and wash water reservoir. The Water Commissioners do not consider it practicable to finance the filtration project at the present time, but the need for low-service storage is so great that they concluded to build the coagulating basins planned as a part of the filtration plant and use them as a low-service reservoir until the filtration plant is built.

The two coagulating basins will adjoin the McCarron pumping station, and will have a capacity of 3,500,000 gal. each. In plan they will be 226x228 ft. They will have a flat slab reinforced-concrete cover. For both basins, about 6,600 cu.yd. of concrete will be required.

The high-service storage reservoir will adjoin the present Dale St. reservoir, but will give 15 ft. more head. The new reservoir will have a capacity of 30,000,000 gal., will be 402x432 ft. in plan, with an average depth of 26 ft., and will be covered by groined arch vaulting sodded over. It will require about 19,000 cu.yd. of concrete.

The new pumping plant, for which contracts have already been awarded, consists of two 7,500,000-gal. electrically driven centrifugal pumps. The contract has been let to the local electric company for "the necessary current" to pump 1,000,000 gal. for $4, giving an overall efficiency of the combined pumping unit of 72%. This price is equivalent to about 0.6c. per kw.-hr. The pumping equipment will cost about $7,700 and the building to accommodate it about $7,500.

The Market for Labor in New England

A thorough investigation of the unskilled labor market in the East has recently been made for the Aberthaw Construction Co. by O. R. Rietschlin, head of the company's employment department.

The territory investigated was the New England States and New York State. Unskilled labor in this territory is chiefly performed by men of the Bulgarian, Greek, Italian, Polish and Portuguese races. There was general agreement among the labor agents, steamship agents, immigration inspectors and Italian bankers interviewed that the supply of this labor available will not begin to meet the demand. Unless there is renewed immigration, the shortage of labor before the summer is far advanced will be very acute. Ordinary unskilled laborers will demand and receive 30c. an hour and possibly more.

Joseph Spano, field secretary of the North American Civic League for Immigrants, reported continuous calls from various mills and public service companies for laborers in lots of 50 to 600, but is unable to supply them. William H. Nitz, Inspector of the U. S. Immigration Service at Boston, reported that the only laborers arriving in any quantity are Portuguese. These, however, go mainly to New Bedford, Providence and Fall River, where relatives already have places for them in the mills. Very few Italian immigrants are arriving, and those that come are either under or over military age or men rejected from the Italian army and not fit for heavy manual labor.

Tables compiled from reports of the U. S. Department of Labor show that in 1913 and in 1914 immigrants from southern Italy to the number of about 13,000 per annum arrived in the New England States, and about 26,000 arrived in New York State. Since June 30, 1914, not only has this normal increase in the number of laborers been eliminated, but 22,000 have left New England and 64,000 have left New York. The figures show moreover that there is no immigration from other races to offset this great reduction in the available labor supply from south Italy.

Water-Works Repairs Following San Diego Storm

The heavy rainfall that destroyed the Lower Otay rock-fill dam on Jan. 27, 1916 (see *Engineering News*, Feb. 3, p. 236, and Feb. 17, p. 334) did much other damage to the water-works of San Diego, Calif. The following review of repair work done in April, 1916, taken from the monthly report of F. M. Lockwood, Manager, Operating Department, City of San Diego, is doubly interesting because it gives some idea not only of the repair work, but also of the nature and extent of the havoc the heavy downpour wrought in addition to the destruction of the dam:

The work of reconstructing the water system is progressing, despite the difficulty encountered in transporting materials for repairs. Although the roads are being rebuilt as rapidly as possible, it is still necessary to use burro pack trains to get material to certain sections of conduit between Morena and Dulzura.

Eight miles of road, which comprises practically all of the road between Barretts and the main county road to Campo have been rebuilt. Four miles of ditch between Dulzura Summit and Barretts have been cleared and excavated to a depth of 5 ft. by 4 ft. wide. Extreme difficulty is encountered in clearing this conduit, it being practically buried in places beneath tons of rocks which have to be blasted before they can be removed.

By the latter part of April the three miles of wood-stave pipe line connecting the Upper and Lower Otay reservoirs was completed. Upon turning the water in, however, the cement lining of one of the tunnels cracked for a distance of 300 ft., allowing the water to escape. This caused a delay of another week in getting the water into the city, during which time the work was rushed on an additional 1,250 ft. of pipe

line necessary to make a connection at the filter plant. This additional line was constructed of 24-in. wood-stave pipe, a shipment of which was rushed from San Francisco. The line was completed within a week's time and the water from the Upper Otay turned into the city mains.

The 20 filter tanks at the Lower Otay reservoir were all cleaned, resanded and put in readiness for operation. A General Electric flow meter was also installed at this point. This is a very sensitive instrument, which, in addition to giving a correct registration of the flow of water at all times, will enable us to tell the instant a break occurs in the pipe on either side of the meter.

In Mission Valley, three of the 80-ft. wells were cleaned out and put in readiness for operation again. Another well required 40 ft. of new casing. These wells were completely submerged and filled in during the winter storms, the pumps and motors in some cases being entirely washed away. Four of these motors were recovered, however, and have been dried out and repaired. Preparations are now under way for the installation of an air-lift system in Mission Valley.

Reduce Accidents at Crossings

Accidents at grade crossings have increased 1,000% in the last five years in some parts of this country, according to a committee report presented at the semi-annual meeting of the American Railway Association, in New York City. This increase is of course due largely to the greater use of the automobile. The special committee which considered this question recommended five specific practices, which were adopted by the association. These were:

Uniform approach warning signs.

Uniform color of light for night indication.

Uniform use of a circular disk approximating 16-in. in diameter, with the word "STOP" painted thereon in large letters, instead of the vari-colored flags which are now in use by crossing watchmen or flagmen.

Uniform painting of crossing gates alternate diagonal stripes of black and white (somewhat like a barber pole).

Uniform rules governing crossing watchmen or flagmen while controlling or regulating streets or highway traffic.

Electric Central-Station Men on Engineering Matters

Electric lighting is by no means the only field now covered by the activities of the National Electric Light Association, and at the annual meeting held in Chicago on May 23-26 the President (E. W. Lloyd) announced that in view of the development of other fields it has been proposed to adopt a more appropriate and descriptive name. The association really represents the electric central-station companies, and its interests are in the widest possible development of the use of central-station current for light, heat and power in both industrial and domestic service. Over 3,000 members and guests were registered. The meetings were held in different rooms of the Auditorium and Congress hotels, and the Auditorium theater was given up for an exhibition of electrical apparatus and appliances. In addition to the general meetings there were separate sessions for five different sections: Technical and hydro-electric, electric vehicles, commercial, accounting, and company sections. There were over 20 sessions during the four days. A system of telephones connected the meeting rooms and each room had signs showing the subject under consideration in that room and all the other rooms, the signs being changed from time to time in accordance with telephone instructions as the meeting progressed.

The rating of lamps by the "lumen," or unit of light flux, was recommended as a substitute for the candle-power rating, which is said to be an inaccurate and inadequate indication of the illuminating power of lamps. An objection was made that this might cause trouble in making contracts for street lighting, but this did not seem to be considered seriously.

Some of the reports reviewed the growing use of incandescent lamps for factory, office, and other interior lighting. Also for outdoor lighting, not only in streets but at tennis courts, athletic fields, steamer piers, etc. In the ornamental lighting of streets and parks the use of standards with more than two lamps was regarded unfavorably. This subject also included the lighting of country highways at public expense, a method which has been adopted in several states, mainly by counties but also by townships. This, however, is practically an undeveloped field as yet.

Of special interest was the subject of outdoor lighting of construction work, and a similar problem is the lighting of railway yards, both for efficiency and safety of operation. For yards, the ordinary arc lamps and luminous arc lamps are considered inferior to "flood lighting" by incandescent lamps with projecting devices. This system of lighting has been applied also to the exterior illumination of public buildings, statuary and fountains in parks, etc.

Power and Heating

Several reports dealt with developing the sale and utilization of current, and increasing the use of current by the introduction of various appliances for household, office and industrial purposes. In a paper by Edgar F. Collins on the resistance heater as a load builder, it was stated that many water-power plants can generate steam for heating more economically by electricity than by fuel-fired boilers. Electric heaters can be applied also to furnaces, foundry and annealing ovens, melting pots for babbitt and type metal and glue, drying kilns, etc. Special reports dealt with electrical heating (industrial and domestic), welding, steel-making furnaces, the operation of ice-making plants, and the use of cooking ranges and numerous household devices.

The use of electric power on engineering construction work was dealt with in rather limited style in one report. The applications noted included compressors, hoists, pumps, concrete mixers and wood-working tools. Particulars were given of the plant used at the Kensico dam and the Catskill aqueduct for the new water supply for New York City, and the Mount Royal tunnel of the Canadian Northern Ry. at Montreal.

Electric Transportation Methods

In view of the possibilities of electric vehicles as a field for central-station current, the National Electric Light Association has secured the affiliation of the former Electric Vehicle Association, which latter now constitutes the electric vehicle section. The papers in this section related to passenger vehicles, motor trucks and the small trucks used in factories and for handling baggage and express matter. Road construction, street paving and street cleaning were also touched upon in their relation to increasing the mileage to be obtained from one charge of a storage battery.

The larger question of electric traction for railways was dealt with in the meetings of the Hydro-Electric Section, the point of view being that the supply of current for city and interurban railways and even for electrified

portions of steam railways, is a promising field for central station companies. One committee report discussed energy supply for electrification of steam railways, and advised power companies to keep this in view in planning for future developments.

Generation and Distribution of Current

The report of the Committee on Prime Movers stated that the feature of the past year is the phenomenal increase in size of steam turbines, while condenser development has kept pace with that of the turbines. Of special interest is the remarkable increase in steam pressures. A paper by Robert Cramer stated that while 200 lb. is still considered high-pressure, several turbine units are being built to operate under 350 lb. and boiler pressures up to 500 or 600 lb. seem to be highly probable. In the discussion there was some question as to whether the results would warrant the increased cost. The committee considered that the "boiler horsepower" for rating the power of boilers is practically meaningless and should give place to something better. The method of stating the ratio of boiler horsepower to engine horsepower was discussed also, and W. L. Abbott (Chicago Edison Co.) suggested that such matters should be submitted to engineering societies and boiler makers. A resolution was adopted urging the American Society of Mechanical Engineers to recommend a method of boiler rating which will be logical and usable.

Hydro-electric development was reviewed by T. C. Martin, and protest was made against the movement for government control of projects for the utilization of water power. Such control was strongly opposed also in an address on "Water-Power Legislation" by Henry J. Pierce, of Seattle, Wash. The latter approved the Shields bill as originally passed by the Senate, but objected to the Adamson bill substituted for this in the House.

Concrete conduit was mentioned in connection with underground work. It is said to resist burnouts better than vitrified tile, and the finished cost of 3½-in. circular concrete conduit is about the same as that of 3½-in. square tile conduit. For protection of transformers on 4,000-volt circuits, lightning arresters were recommended on the transformer poles rather than the line poles; arresters at a distance of 1,000 ft. give very little protection. Developments in meters and other electric apparatus were covered in several reports. The U. S. Bureau of Standards was criticized for its rules on overhead construction, which are considered not only unreasonably severe, but tending to check the development of rural lines by the higher cost involved.

The new President is Herbert A. Wagner, President of the Consolidated Gas, Electric Light and Power Co., of Baltimore, Md. The Secretary is T. C. Martin, of New York, N. Y.

A Short Course in Concrete Engineering for manual training and vocational teachers is to be conducted by the Extension Division of the Portland Cement Association in Chicago from June 26 to July 1, 1916. The course is free to supervisors and instructors in manual-training work.

Parts of the Plumbing Ordinance of Lexington, Ky., have been declared unconstitutional by the judge of the Circuit Court. The ordinance provided among other things that each master plumber must pay a license fee of $5 and each journeyman plumber a fee of $1, and that these licenses would be renewed annually upon payment of 50c. The ordinance also provided that only plumbers who had passed an examination as required in the ordinance were eligible to receive a license. This provision the court held to be discriminatory. The ordinance also provided that the salary of the plumbing inspector should be paid from license or registration fees from the plumbers of the city. This provision was also held to be unconstitutional.

Good Water-Works in the Philippine Islands are increasing in favor, according to the Bureau of Public Works in Manila, which, "Commerce Reports" states, is receiving requests from all parts of the islands for the installation of water-works systems. Only 12 municipalities in the Philippines can boast of modern water systems, but the bureau has in preparation plans for six additional systems. At San Pablo the construction of a water-works system was begun about a year ago, and it is now nearly completed. The source of this system is a large spring located in the foothills, the capacity of which is 2,000,000 gal. per 24 hr. They are all gravity systems with the exception of the water-works at Taal which includes a pumping plant equipped with Diesel engines.

Lightning Protection for Water Towers was dealt with in a report presented at the meeting of the National Fire Protection Association at Chicago, May 9-11. For a wood tank on a steel tower an air terminal at the apex of the roof is sufficient, with the conductor extending from this bonded to the top of the tower, and a ground rod bonded to the bottom of the tower and extended into the earth. Structures over 60 ft. high should have at least two ground rods. If the roof is of metal, this may serve as the terminal, the conductor being bonded to it. For steel tanks on steel towers only the ground rods are needed. The bonding should be done by soldering one end of the conductor into a threaded brass plug and screwing this plug tightly into a tapped hole in the steel frame.

The Second Annual State-Wide Good Roads Day in Pennsylvania was observed May 25 and according to reports received by Chief Engineer William D. Uhler of the State Highway Department more than 80,000 volunteers worked on roads in the 67 counties of the state. Many carloads of road materials were donated by corporations and public-spirited citizens. In the western counties several thousand men worked on the proposed William Penn Highway, which will connect Philadelphia and Pittsburgh. Governor Martin G. Brumbaugh with other officials inspected work in Cumberland, Perry and Dauphin Counties and the Governor himself donned overalls and guided a plow at several places. The Governor was a farmer before he became an educator and politician and was well able to do his bit.

Water Mains and Fire Hydrants in relation to city planning have been made the subject of a questionnaire by a recently appointed Committee on City Planning of the American Water-Works Association, the chairman of which is E. P. Goodrich, 35 Nassau St., New York City. A half-dozen questions relate to pipe location, and a score or so to fire hydrants. The fire-hydrant questions deal, first, with the relative advantages of hydrants located above and below the sidewalk level and, second, with the location of the hydrants longitudinally or in relation to position in the length of the block, and laterally or with respect to position at the curb line or between the curb and the building line. The committee will doubtless be glad to receive information from nonmembers as well as members of the association. Copies of the questionnaire may be obtained by addressing Mr. Goodrich.

A New Cause for Water Waste—In the operation of model tenements in Cincinnati and in Washington, where water is furnished free to the tenants, it is found that the water bill amounts on the average to about one-eighth the rental. It has also been found that the consumption of water by negro tenants exceeds the consumption by white tenants. A neighborhood visitor called at a colored tenement, and as the door was opened to her she heard the splashing of water in the back of the room where a wide-open faucet was discharging a full stream of water into the sink. The visitor turned off the faucet and said to the colored woman: "Why, Molly, what do you keep the water running for when you are not using it?" "Well, you see, mum," replied the colored woman, "I gets mighty lonesome sometimes and dat ar water a-runnin' is a powerful sight o' company."

Halifax Harbor Work in the construction of the new Ocean Terminals described so extensively in "Engineering News" during the last six months is progressing favorably. The railway is almost completed to grade throughout and the contractors are now trimming slopes and cleaning up subgrade. A large part of the terminal yard in Bedford Basin has been in use for some months past. The sectional hollow concrete quay blocks have been laid for about 1,300 ft. of wall and foundations are ready for about 1,000 ft. more. The diving bell has been preparing foundations at a rate of 80 to 100 ft. per week. The rock dredging in the harbor is practically complete. The placing of mass concrete foundations in the

wet at depths from 45 ft. to 60 ft. below low water is being proceeded with and about 300 ft. of wall foundations have already been successfully prepared in this way. The seats on the top of the mass work to receive the cellular blocks have been prepared by helmet divers. This has been necessary to make time, as the diving bell has been fully employed working night and day on other sections.

New York Is Now the Leading Commercial Seaport of the world, according to statistics just made public by the Department of Commerce. The "Statistical Abstract of the United States for 1915," just issued by the Department, shows imports and exports at New York in the last fiscal year amounting to $2,125,000,000. This is some $200,000,000 greater than the commerce of London. The fiscal year ending June 30, 1916, will show a further great increase in the commerce of New York. The following table shows the imports and exports of New York compared with the four other greatest world ports, the figures being for the latest year available.

Ports	Imports (Millions of dollars)	Exports
New York	931.9	1,193.6
London	1,232.1	696.0
Hamburg	1,084.3	817.3
Antwerp	623.2	588.2
Liverpool	810.0	836.0

Leaky Steel Distributing Mains at Galt, Ont., are said to have contributed to the recent temporary failure of the water-supply of that city. On the evening of Mar. 10, 1916, the Imperial Hotel caught fire. The water pressure failed almost instantly. Assistance was promptly rendered by fire pumps in two different mills, but for more than two hours after the fire started the city pumps were of little or no service, even though many valves were shut in mains nearest the hydrants in use. When the fire broke out, the two centrifugal pumps, run in tandem, were out of commission owing to the fact that the 125-kv.-a. motor which drives them had burned out a few days before and was being repaired. Of the two steam pumps, one was operating when the fire alarm sounded, but it is said that the steam supply is low, so time was lost in getting the second steam pump going. In addition to the pump troubles, the 275,000-gal. standpipe was empty. It is reported that this was due to leaks in steel distributing mains laid a few years ago, including a large main in Ainsley St. These mains had given much trouble, it is said, for the past two years from badly leaking joints and from leaks due to corrosion in the body of the pipe. The day after the fire steps were taken to secure a 250-kv.-a. motor, so the two centrifugal pumps can be run separately hereafter; to replace all the steel pipe with cast iron; and to drill a new well at the pumping station.

PERSONALS

Mr. R. T. Wells has resigned as City Engineer of Parsons, Kan.

Mr. S. K. Titus has resigned as City Engineer of Arkansas City, Kan.

Mr. J. R. Crissey has been appointed City Engineer of Johnstown, Penn. He succeeds Lee Masterson.

Mr. Charles Pratt, formerly City Engineer of Chanute, Kan., has been appointed City Engineer of Erie, Kan.

Mr. G. N. Wood, formerly Assistant City Engineer of Douglas, Ariz., has been appointed City Engineer of Chanute, Kan.

Mr. G. A. Harwood has been appointed Engineering Assistant to the Vice-President of Operation of the New York Central Railroad Co.

Mr. Frank A. Probert, M. Am. Inst. M. E., Consulting Engineer, San Francisco, has been appointed Professor of Mining in the University of California.

Mr. Frank Adams, of the United States Department of Agriculture, has been appointed Professor of Irrigation Investigations in the University of California.

Mr. J. S. Langthorn, M. Am. Soc. C. E., formerly Division Engineer, Board of Water Supply, New York City, has been appointed Deputy Commissioner, Department of Water-Supply, Gas and Electricity, New York City.

Mr. Andrew C. Lawson, M. Am. Inst. M. E., Professor of Geology and Mineralogy in the University of California, has been appointed Dean of the College of Mining in that University.

Mr. H. S. Morse, M. Am. Soc. C. E., Director of the Cincinnati Bureau of Municipal Research, has resigned to take charge of the Department of Public Works of the Detroit Bureau of Governmental Research, recently organized to conduct municipal, state and national government research.

Mr. Howard E. Hyde, M. Am. Soc. C. E., formerly Acting City Engineer of Manila, and for many years Principal Assistant Engineer of the Sewerage System and Street Paving of Havana, Cuba, has resigned his position as Assistant Engineer, Water-Supply Board of Providence, R. I., and will hereafter become actively connected with the firm of Young & Hyde, Inc., Contracting Engineers, Produce Exchange Bldg., New York City, with which he has been indirectly connected for several years.

Mr. William Bowie, of the United States Coast and Geodetic Survey, has been appointed a member from the United States of the Permanent Commission of the International Geodetic Association. Since 1909 Mr. Bowie has been Chief of the Division of Geodesy of the Survey, and in 1912 was one of the delegates from the United States to the convention of the International Geodetic Association at Hamburg, Germany. This association was organized more than 50 years ago for the purpose of securing the cooperation of the European nations in undertaking certain geodetic problems which were international in scope.

OBITUARY

James J. Hill, railroad builder, capitalist and most widely known figure of the Northwest, died at his St. Paul, Minn., residence on May 29, as the result of an infection caused by intestinal trouble. J. J. Hill was born near Guelph, Ont., on Sept. 16, 1838. He immigrated to the United States, reaching St. Paul in 1856. In 1870 he organized the Red River Valley Transportation Co. and began development of the Red River Valley, out of which project grew a syndicate that eventually took over the St. Paul & Pacific Ry.—which later became the Great Northern Ry. In 1901 the Hill interests bought the Chicago, Burlington & Quincy R.R.; and in 1907 the fourteen railways operated subsidiary to the Great Northern were purchased by the latter and operated as a part of the Great Northern system.

Lieut. James Vincent Rockwell, M. Am. Soc. C. E., Civil Engineer in the United States Navy, was killed on May 24, at Pensacola, Fla., where he was training as an aviator. The aëroplane he was piloting dived into the Gulf. Lieutenant Rockwell was born in Indiana and appointed to the service from Iowa. He was 39 years old.

Prof. Webster Wells, who was for 38 years on the teaching staff of the Massachusetts Institute of Technology, died, on May 23, in Arlington, Mass. He was born in Boston, in 1851, and graduated from the Institute in 1873, taking up his life work there immediately afterward. Professor Wells was the author of many standard textbooks on mathematics, which gained him a national reputation.

ENGINEERING SOCIETIES

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

SOCIETY OF AUTOMOBILE ENGINEERS.
June 12-16. Summer meeting (cruise on Lake Huron and Georgian Bay). Secy., Coker F. Clarkson, 29 W. 39th St., New York City.

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting, Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.
June 14-21. Convention in Atlantic City. Secy., J. D. Conway, 2136 Oliver Bldg., Pittsburgh.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
June 19-21. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION
June 19-22. Annual meeting in Charlottesville, Va. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

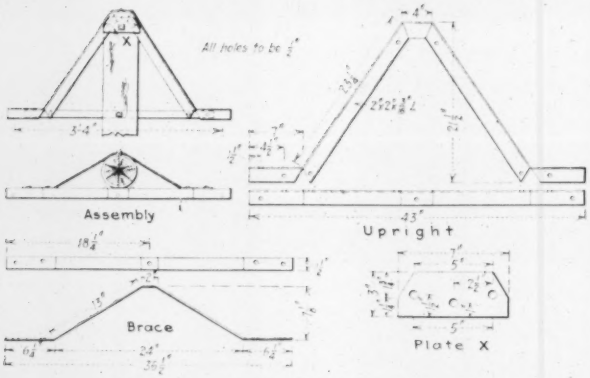
AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

Appliances and Materials

Steel Crossarm for Power Lines

A simply constructed and easily erected steel crossarm for wood poles on electric-power transmission lines has been devised by E. C. van Diest, Consulting Engineer, Colorado Springs, Colo. It was designed originally for the transmission lines of the Intermountain Railway, Light and Power Co., Holdrege, Neb. It has served the purpose so well that a patent has been applied for. It is now being manufactured by the Associated Engineers Co., Colorado Springs. The accompanying sketch gives the details of this new crossarm.

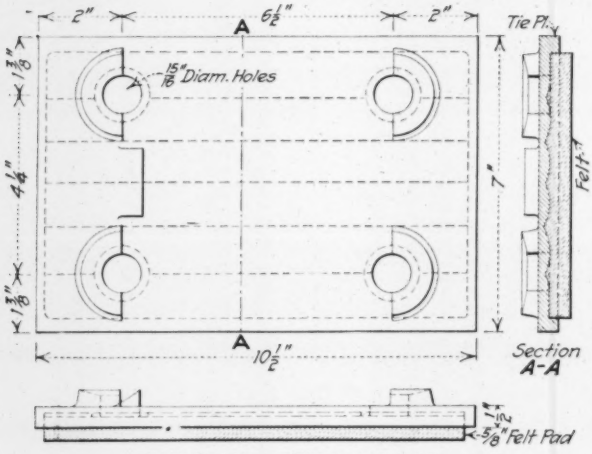


STEEL CROSSARM FOR POWER POLES

* * *

Track Tie-Plates with Felt Pads

To reduce noise of trains in large terminal stations and on elevated railways use is being made of padded tie-plates, having a felt pad between the plate and the tie. The accompanying drawing shows a form of tie-plate having a recess in the bottom to receive the pad and thus hold it securely.



TIE-PLATE WITH FELT PAD

The pad is of cow-hair felt, about 5/8-in. thick. Tie-plates of this design are in use in the electric railway terminal of the Public Service Ry., at Newark, N. J., and on the Chicago elevated railways.

Padded tie-plates in which the pad is simply placed beneath the plate, and not held in a recess, are used extensively at New York City in the Pennsylvania R.R. terminal, the Grand Central Station, and the rapid-transit subways. The use of the pads is mainly to reduce the noise, but they also serve to protect the wood from abrasion, as it is some time before the pad allows the tie-plate to come in contact with the tie. By incasing and holding the pad, as in the design illustrated, it cannot so soon spread or crush down, and its life is thus increased materially. These padded tie-plates are manufactured by the Track Specialties Co., 29 Broadway, New York, N. Y.

* * *

Track-Bonding Drill

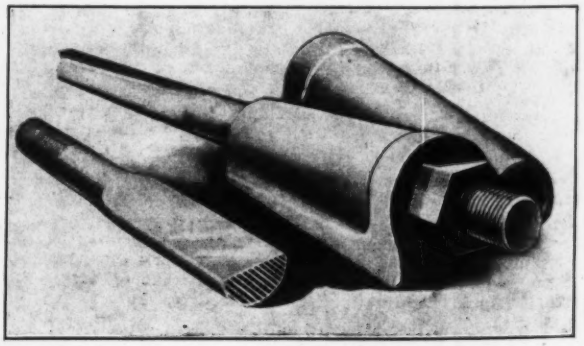
The new tool shown herewith is for drilling bond holes in rails. It has no base plate but is secured directly to the rail by clamps which provide for rails of different base widths and heads of different sizes. The clamps grip the rail at two points, and are engaged or released by the movement of a hand lever. The revolution and feed of the drill are effected by two chains with sprockets on a crank-handle shaft. The driving sprocket is disengaged to allow of moving the drill to and from the rail, and an idler is provided for adjusting the tension on the feed screw. An improved chuck and spindle dispense with the need of a setscrew to hold the drill. The machine weighs about 30 lb. complete. It is known as the Buda-Wilson track bonding drill, and is manufactured by the Buda Co., of Chicago.

TRACK-BONDING DRILL

* * *

Half-Round Tank Hoops

Tank hoops of half-round section brought out recently by the U. S. Wind Engine and Tank Co., of Batavia, Ill., are shown herewith. This section combines ample strength with a minimum of exposed and inaccessible surfaces. It has a smaller exposed surface than the ordinary wide flat band, and it does not crush the wood or form a dust-collecting gutter (to start corrosion) like a round rod. The lugs keep the ends of the hoops clear of the tank, so that they will not injure the wood.



HALF-ROUND HOOPS FOR TANKS

Encyclopedia em Portuguez de Machinas para Construcções, Pagina 84

Engineering Library
PERIODICAL ROOM
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1916

Engineering News

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Hill Publishing Company

NEW YORK, JUNE 8, 1916

Price, 15 Cents
Contents, First Page
Advertising Index, Last Page

TREATMENT designed to eliminate and postpone decay usually gives timber certain characteristics which render it impossible for or, at least very disadvantageous for a wide range of uses.

BERLIN MILLS KYANIZED SPRUCE is a treated timber—practically immune to decay—which has no bleed, no disagreeable odor, which is *less* inflammable than ordinary wood.

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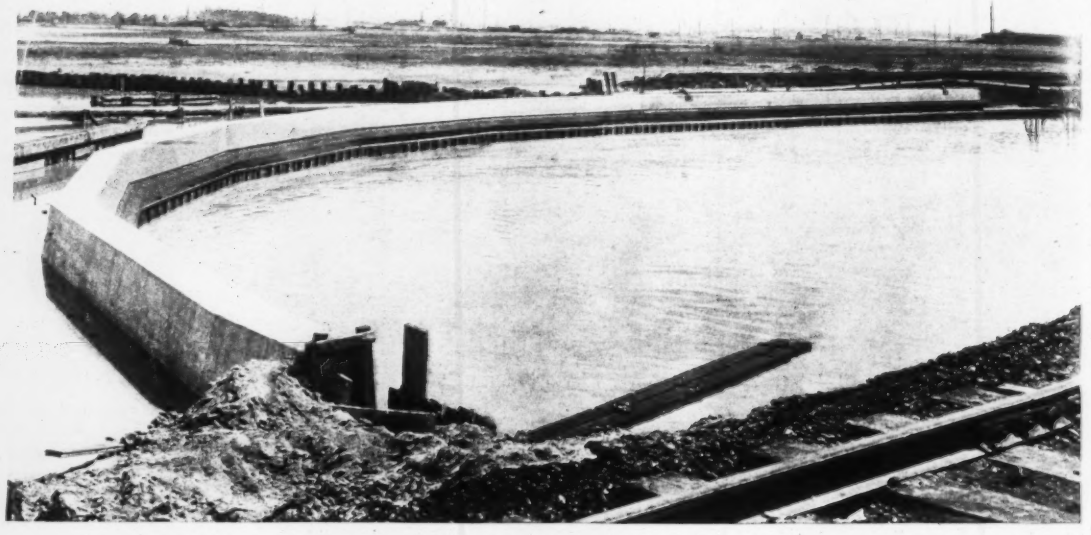
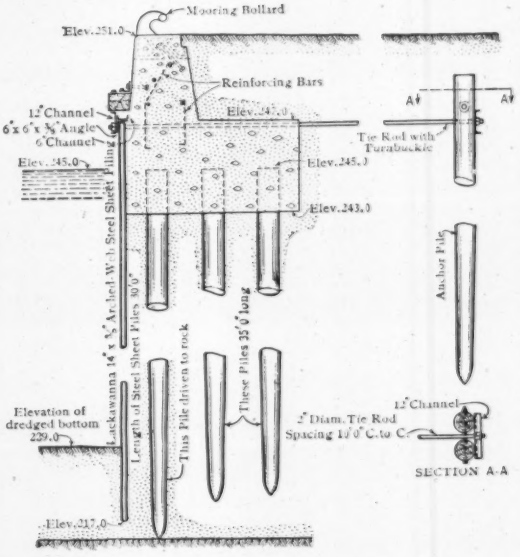


Lackawanna Steel Sheet Piling Offers Strength, Economy, Permanence and Pleasing Appearance In The Construction Of Dock Walls, Shore Revetments, Etc.

Herewith are shown the design and part of the 2,600 lineal feet of Lackawanna Steel Sheet Piling and concrete dock wall built by the Toronto Harbor Commission on the Don River Diversion as part of Toronto Harbor improvement.

Note particularly the pleasing appearance, the good alignment and the perfect angles, which with the Lackawanna type of interlock are easily obtained.

Our Steel Sheet Piling Engineers have on file numerous desirable designs for such walls, with sheet piling protected by concrete for its entire depth, down to water line only or merely capped with concrete. Other designs, if desirable, will gladly be suggested and we will also cooperate in figuring costs, labor requirements, etc. Contractors interested in this class of work should send for our book—"Lackawanna Steel Sheet Piling."



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Engineering News

VOLUME 75 JUNE 8, 1916 NUMBER 23

Plate Girders of Record Weight in Worcester Viaduct

By F. B. Freeman*

Reference was made in *Engineering News* of Dec. 9, 1915, in the course of the description of long plate girders for the Nickel Plate railroad at Chicago, to the fact that much heavier girders were used in grade-crossing elimination at Worcester, Mass., three years ago. These heavy girders were constructed by the Boston & Albany R.R. (not by the New York, New Haven & Hartford R.R., as stated in the article). A description of some of the interesting features of these girders is given below.

The elimination of grade crossings through Worcester, Mass., necessitated the construction of an unusually long and heavy solid-floor viaduct at South Worcester to carry the tracks of the Boston & Albany R.R. across Southbridge St. and the tracks of the New York, New Haven & Hartford R.R.

The four tracks of the latter road cross Southbridge St. by means of a through truss span at a distance of about 26 ft. below the tracks of the Boston & Albany, which cross the street on a deck truss span. The tracks of the New York, New Haven & Hartford run parallel to those of the Boston & Albany until they reach the westerly end of the truss span, when they make a turn south and pass beneath the Boston & Albany tracks, which cross them by means of several plate-girder spans carried on two piers. From a freight yard north of the bridge three tracks of the New York, New Haven & Hartford join with two of the main tracks at a point beneath the westerly span of the bridge.

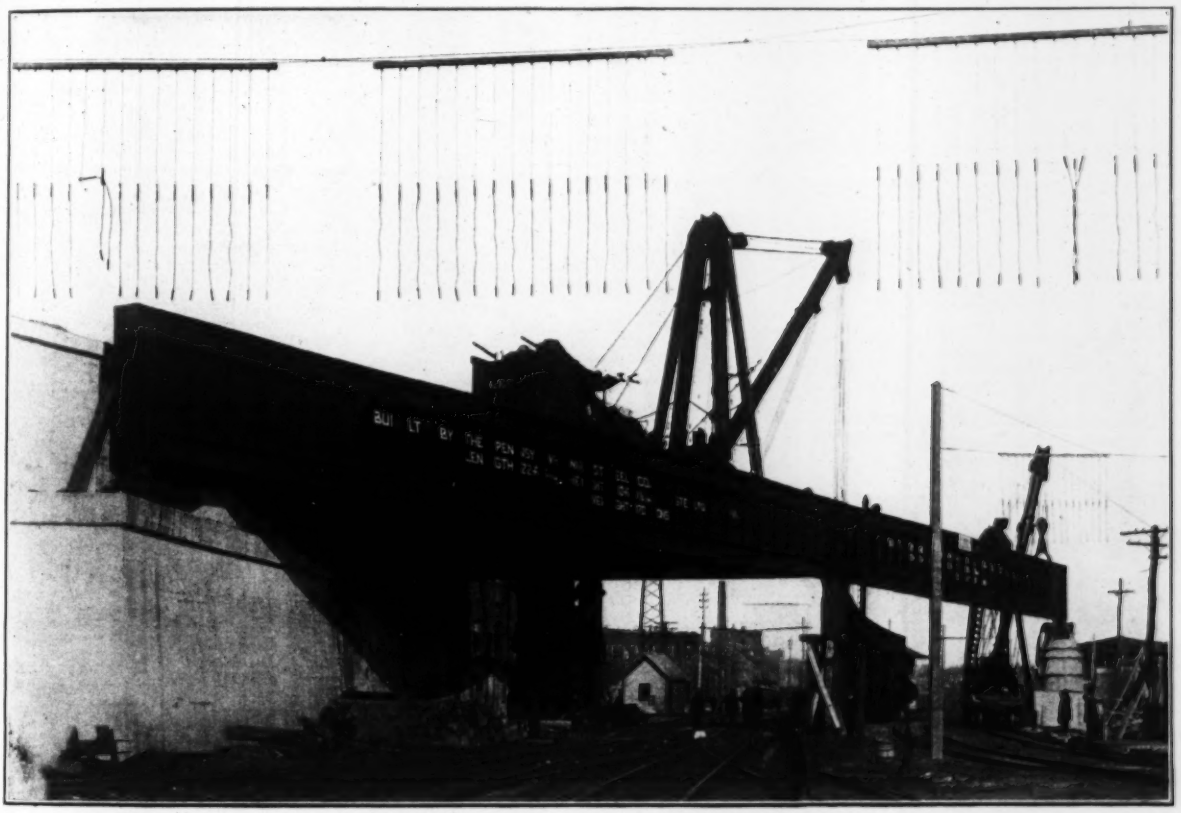

FIG. 1. THE 170-TON PLATE GIRDER IN PLACE; ERECTING THE ADJOINING GIRDER G3
Part of floor-beams to abutment in place

*Chief Engineer, Boston & Albany R.R.; South Station, Boston, Mass.

With this layout of tracks and crossovers and switches it was necessary to divide the portion of the bridge west of Southbridge St. into three spans of deck plate-girders, supported on a pier between the two middle tracks of the New York, New Haven & Hartford R.R., a pier south of the southerly main tracks, and two abutments, one west of the New York, New Haven & Hartford tracks and the other at the end of the Southbridge St. truss span. Referring to the plan, it will be seen that the westerly pier was constructed on a curve parallel to the at right angles to the abutments and piers and [illegible] into long girders. The span over Southbridge [illegible] is made up of five lines of deck riveted Warren [illegible] with a floor system of I-beams resting on the top [illegible] trusses. The entire bridge floor is covered with a reinforced-concrete slab.

The floor girders over the New Haven railroad tracks are entirely incased in concrete, with a slab on the under side to eliminate all pockets which might hold locomotive gases. In the under side of this slab are embedded

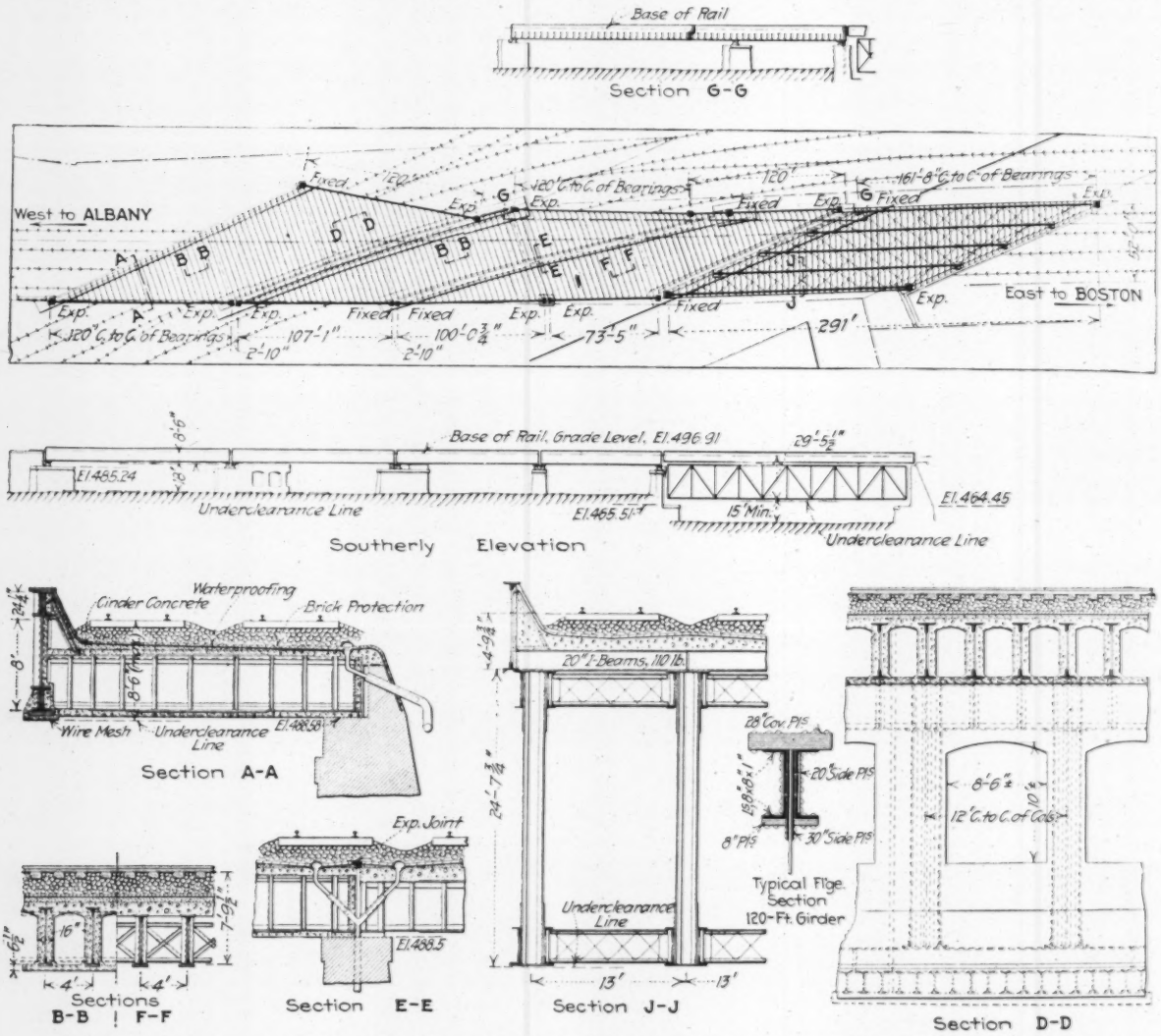

FIG. 2. GENERAL PLAN AND ESSENTIAL DETAILS OF ARRANGEMENT, WORCESTER TRACK ELEVATION, BOSTON & ALBANY R.R.

adjoining tracks, in order to obtain the required side clearance at all points. The west abutment was built parallel to the extreme westerly yard track of the New Haven railroad, which, being on a tangent, was at no point parallel to the pier. The easterly pier, adjacent to the southerly New Haven main track, was built parallel to it. The abutment on the west side of Southbridge St. was built on the street line. None of the piers or abutments except those of the street span were parallel to each other.

In general, the superstructure, except for the street span, consists of deck plate-girders placed approximately hard-glazed tile for protection against the locomotive blast. The girders between the truss span and the easterly pier adjacent to the tracks are not incased. The bottom flanges of the long fascia girders were incased in concrete and the portions directly over the tracks are protected from the locomotive blast by cast-iron blast guards. The entire floor slab is covered with a crowning of cinder concrete to afford the necessary slopes to carry drain water. This cinder-concrete crown is covered with a 2-ply thickness of Minwax waterproofing, protected by a layer of brick. Regular track construction with stone ballast is placed over the entire floor.

The most interesting features in connection with this bridge were the construction and shipment of the heavy plate girders.

The shortest distances between the piers and abutments were at the south side of the bridge, where the maximum length of the girder required, at the southwest end of the bridge, was 122 ft. 6 in. overall. This length of 122 ft. 6 in., girder *G4*, was established as a limit. In order to keep the girders on the north side of the bridge within this limit, it was necessary to construct the northwest girder at an angle to the tracks. The girder between the Southbridge St. abutment and the easterly pier was constructed with a cantilever arm of 26 ft. overhanging the pier, in order to keep the next girder west, *G6*, within the established limit for length. This girder was also placed at a slight angle with the tracks for the same reason.

Girder *G4*, the southwesterly one, is the heaviest in the structure, weighing 170 tons. Its dimensions are: Length 122 ft. 6 in., depth 10 ft. 11½ in. Each flange is made up of four 8x8x1-in. angles, two side plates 6x1 in.; two side plates 30x1 in.; nine cover plates 28x⅝ in., and six plates 8x¾ in. The main web of the girder is 1 in. thick throughout, with a 1-in. reinforcing web at the east end (which receives the greater reaction). The 30x1-in. side plate is discontinued at the point where the reinforcing web begins and is spliced to this web.

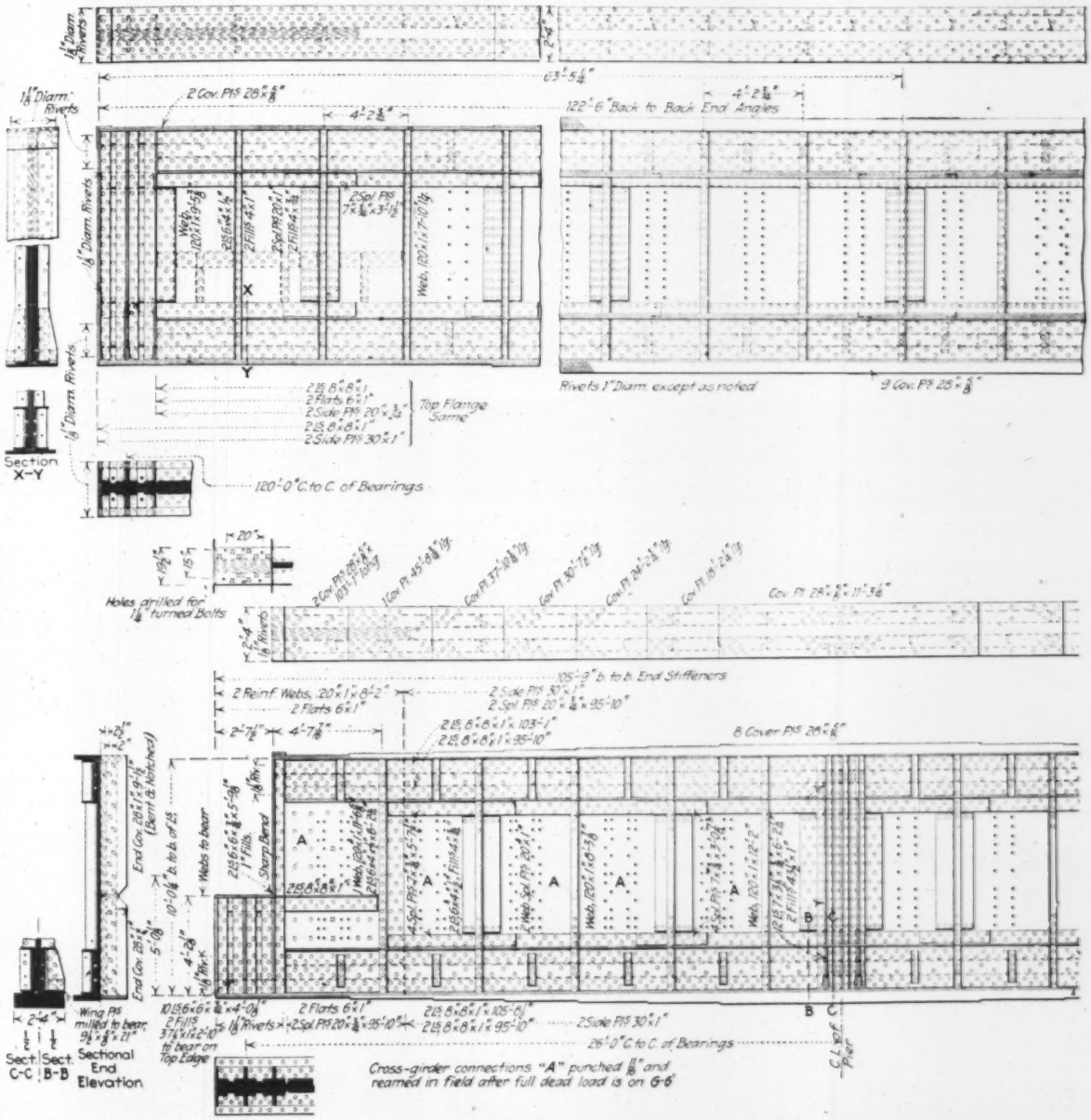
1⅛" Diam. Rivets
2 Cov. Pls 28"x⅝"
122'-6" Back to Back End Angles
Rivets 1" Diam. except as noted
9 Cov. Pls 25"x⅞"
Top Flange Same
Section X-Y
120'-0" C. to C. of Bearings
Holes drilled for 1⅛" turned Bolts
105'-9" b. to b. End Stiffeners
2 Reinf. Webs, 20"x1"x8'-2"
2 Flats 6"x1"
2 Side Pls 30"x1"
8 Cover Pls 28"x⅝"
Wing Pls milled to bear, 9½"x⅝"x21"
Sect C-C
Sect B-B
Sectional End Elevation
2 Flats 6"x1"
26'-0" C. to C. of Bearings
Cross-girder connections "A" punched 1⅛" and reamed in field after full dead load is on G-6

FIG. 3. DETAILS OF THE 170-TON GIRDER G4 (ABOVE) AND THE CANTILEVER GIRDER G6 (BELOW)

The web is fully spliced at all splices for both moment and shear. The shear splices are made up of vertical 20x1-in. plates each side of the web extending between the side plates. The moment splices are horizontal 20x¾-in. plates between the flange angles and 7x¾-in. plates beneath them. On account of the short distance

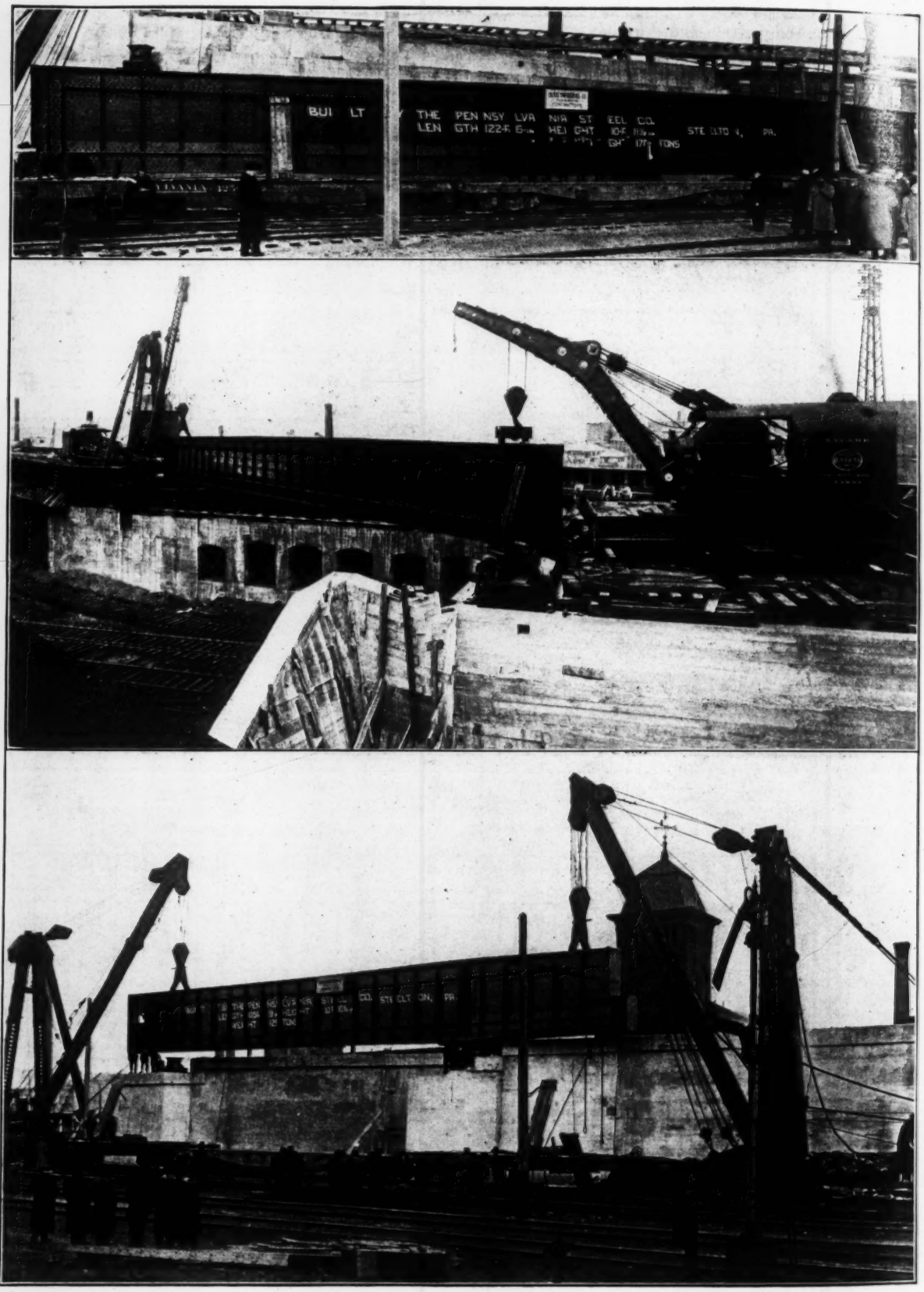

FIG. 4. ERECTION OF HEAVY GIRDER WORK, WORCESTER TRACK ELEVATION, BOSTON & ALBANY R.R.
Upper—The 170-ton girder on cars. Middle—Ready to set girder G7; view shows steel bent incased in concrete.
Lower—Erecting the cantilever G5; both derricks on lower track

between splices, the 20x¾-in. horizontal splice plates were made continuous for nearly the full length of the girder and were used to splice the 30x1-in. side plates. The arrangement of this material is shown by section of the flange, in Fig. 3.

With these heavy flanges the grip of the rivets is 7½ in. through the web, side plates, angles and splice plates at the stiffeners, and 6⅝ in. through the angles and cover plates. On account of this long grip, and also in order to keep the pitch of rivets within reasonable limits, it was decided to make all flange rivets through the web and angles, and through cover plates and angles, 1⅛ in. diameter; throughout the remainder of the girder 1-in. rivets were used.

The Cantilever Girder and Its Anchorage

Cantilever girder *G5* was proportioned with reference to the deflection of the cantilever end. This deflection was kept down to $\frac{3}{16}$ in., of which $\frac{3}{64}$ in. was due to live-load. The maximum unit-stress over the fulcrum point of the top flange was kept below 12,000 lb. per sq.in., in order to limit the deflection. The cantilever end was also stiffened by extending five of the short girders over the east pier and riveting them to it, their opposite ends being anchored to the masonry. The anchorage of the cantilever girder *G5* is made up of channels and plates extending 35 ft. into the abutment. This anchorage is connected to a casting by a pin with an adjustment device consisting of cast wedges resting in a slot cut in the end of the girder.

The westerly pier between the tracks beneath the bridge was limited to a width of 4 ft. The load is evenly distributed over the pier by the cross-girders, except at the ends where the long fascia girders are supported. The pier is made up of steel columns incased in concrete. The columns, spaced 12 ft., support box girders on which the cross-girders rest. At the lower ends the columns are supported on two grillages of girder beams, one above the other, incased in concrete. The grillages for the columns are independent of each other, but the concrete is constructed as a monolith. At the south end of the steel pier the column supporting the ends of the long girders *G3* and *G4* is of unusual size, as the concentration carried by it is about 2,000 tons. The size of the grillages under this column is increased above that for the regular columns. The load is carried into this column through a special shoe consisting of two separate upper castings, one for each girder, supported on a common lower casting by means of heavy forged link bars. This design permits the expansion of both girders over the pier, at the same time anchoring them securely to it.

How the Heavy Girders Were Shipped

One of the first questions that came up with the construction of the heavy girders was the matter of shipment, on account of the unusual dimensions and weights. The Pennsylvania Steel Co., which held the contract for the fabrication and erection of this bridge, obtained the use of two steel well-hole flats of Class FN belonging to the Pennsylvania R.R. These cars consisted of two longitudinal box girders, one at each side of the car, connected at each end by two transverse girders, with a well-hole in the center of the car. The cars have a capacity of 175,000 lb. with the load placed over the trucks, and 150,000 lb. with load placed at center of car.

While these cars could have carried the large girders with the points of support directly over the trucks and not exceeded their capacity, the axle concentrations would have been too large for shipment over the lines interested. On the other hand, with the points of support in the center between trucks, the capacity of the cars would have been exceeded. The Pennsylvania Steel Co. therefore framed two new cross-girders in the well-holes, well back toward each truck, and between them two new longitudinal girders. With this alteration the girders were supported in the center of the car. The usual shores and bolsters for shipping large girders were provided, with special arrangements made for keeping the chafing plates between upper and lower bolsters well lubricated, by the use of compression oil cups. After each shipment the chafing plates were thoroughly cleaned and the oil cups refilled.

The girders were routed via Pennsylvania R.R. to Wilkesbarre, Penn., Delaware & Hudson Co. to Albany, N. Y., and Boston & Albany R.R. to Worcester, Mass.

The average time from date of shipment of a girder to date of its erection was five days. The average time between date of shipment of one girder until date of return of cars and shipment of next was eleven days. These two cars were the only ones which the Pennsylvania Steel Co. was able to obtain on which to ship the girders, and it was necessary to have the girders arrive at the bridge site in the order needed for erection, so that they could be taken care of on alternate Sundays. The distance involved in shipment was 487 mi. each way.

Engineers and Contractors

The erection of the superstructure was started Jan. 7, 1912, by the placing of the 170-ton girder *G4*, and was completed May 3, 1912. The erection of the plate-girder work was completed Feb. 29, 1912. The erection of the truss span was begun Mar. 4, 1912, and completed May 3, 1912.

The Pennsylvania Steel Co., Steelton, Penn., as contractor for the fabrication and erection of the steelwork, sublet the erection to the Lucius Engineering Co., of Pittsburgh, Penn.

The bridge was designed and built under the direction of the Engineering Department of the Boston & Albany R.R.

The City of New York Expended $192,877,000 in 1915, and during the current year will expend $194,981,000, according to figures made public by Comptroller Prendergast. Adding to this sum the state taxes on residents of the city, which are assessed and collected by the city, the total taxes paid in New York City this year for municipal, county and state government will be $212,956,000. The distribution of the money raised for various purposes is shown by the following table, which is compiled to indicate how the sum of $100 paid in taxes will be distributed in 1916:

Interest on city debt	$21.55
Payments on principal of city debt	10.87
Total for city debt	$32.42
Public education, including colleges and libraries	21.81
Protection of life and property—police and fire departments, street lighting and state militia	15.61
Health and sanitation, including street cleaning	8.40
Public charities and charitable institutions	5.12
Courts, prosecuting attorneys, coroners, sheriffs, etc.	4.97
Maintaining streets, paving, sewers, public buildings, etc.	3.69
Docks, ferries and bridges	1.15
Public amusements, parks, museums, etc.	1.61
All other expenses	5.22

Irrigation Headworks Repair and Dam Failure

By W. G. Bligh*

SYNOPSIS—Reconstruction of the headworks of the canal for the Southern Alberta Land and Irrigation Co. on Bow River, in Alberta. Failure described in earlier issue of "Engineering News." Description of more recent failure of part of the main dam or weir at the headworks, a concrete structure on porous foundations.

An article by the writer in *Engineering News*, Feb. 6, 1913, described the failure of the headworks of a canal, the name and location of which were then for certain reasons withheld. The canal in question is that of the Southern Alberta Land and Irrigation Co. near Medicine Hat, Alta., a general description of which was given in *Engineering News*, Aug. 13, 1914, p. 354. During the two years and over that have elapsed since the destruction of the intake and weir sluices, the canal works have passed under new professional direction, the headworks in question have been rebuilt and other works of considerable

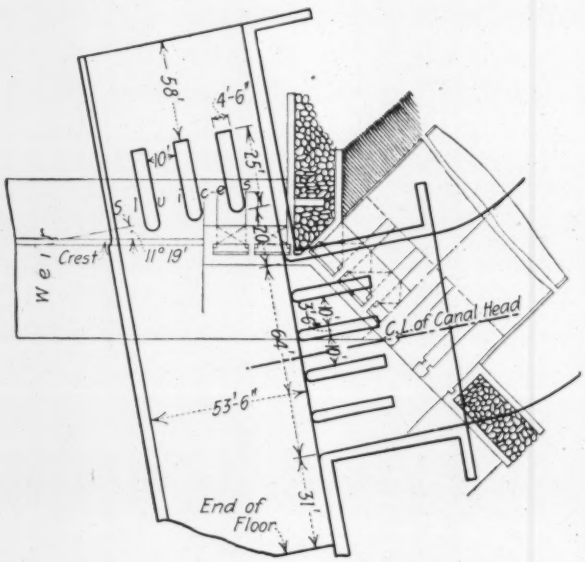

FIG. 1. ORIGINAL AND PRESENT LAYOUT OF HEADWORKS AND WEIR SLUICES, NAMAKA DAM, ALBERTA
Original shown light, present shown heavy

magnitude have been constructed. Meanwhile a second catastrophe occurred in June of last year, when a record flood in the Bow River caused the collapse of the main dam, a failure incidentally predicted in the article alluded to. In the present article it is proposed to deal first with the new intake and weir sluices and then with the failure of the weir itself. It is known as the Namaka Dam.

The destroyed headworks were rebuilt on very nearly the same site as before, but the faulty alignment of the canal head relative to the sluices, to which point attention was drawn in the previous article, is corrected in the new work, the intake being now located at right angles to the weir sluices. Fig. 1 shows the relative positions of the old and new works, and Fig. 2 is a complete plan of the whole new headworks. It will be noticed that the sluices are aligned at an angle of 11° 19′, set inward from the axis of the weir. This arrangement reduces the curvature required in the earth channel of the canal to effect a junction with the existing cut.

The waterway provided for the new intake is the same as before—that is, five openings of 10 ft. each. The opening of the weir sluices has been increased from two to four spans of 10 ft. each. It would undoubtedly have been a better arrangement to have adopted two openings of 20 ft. for the weir sluices for the reason that the less obstruction offered in the way of piers the greater will be their scouring capacity, but considerations of economy in first cost dominated all others in the design of the new headworks and the retention of the original spans of 10 ft. enabled the Stoney gates and their appurtenances, which were salvaged from the old wreck, to be utilized. For the closure of the canal head the old gates, which have a depth of only 8 ft., are not very suitable. Under existing conditions the adoption of double draw gates working in separate grooves, thus enabling flood water to be drawn off over the lower leaf, would seem to be the best possible installation. These gates are usually mounted on small antifriction wheels, which is a much simpler arrangement than Stoney roller trains. In the present instance the most economical means of regulation, that of wooden vertical needles, had to be adopted. These bear against a raised sill at the bottom and a concrete slab at the top.

The excellent arrangements adopted for the effective scour of heavy deposit in front of the canal intake are shown in Fig. 2. The sill of the intake is raised 5 ft. above its floor level and above that of the scouring-sluice approach channel. This arrangement admits of the accumulation of silt and boulders to a depth of over 5 ft. in the scouring channel, which would otherwise find its way into the canal but which now can be washed out when desired by opening the weir sluice gates. This channel is cut off from the weir by divide walls below as well as above the sluice regulator, which cause concentration of the current, thus rendering it more effective. The channel is paved with boulder masonry, which construction is cheaper than concrete.

With regard to uplift and subpercolation, neglect of which matters caused the former disaster, the sluice head is amply protected by the long floor in its rear. The value of L, or the effective length of percolation, is 206 ft., while that of H cannot exceed 10 or at the most 12 ft. C, or the ratio L to H, comes to 17, whereas a value of 6 is considered sufficient for a boulder bed such as that of the Bow River. The uplift on the sluice head and on the solid floor beyond it is amply cared for by the weight of the structure itself and the thickness given to the floor. The canal head has $L = 110$ ft. and on the improbable assumption that the canal is completely closed during the highest floods, H will be 18 ft., making $C = 6$, which is

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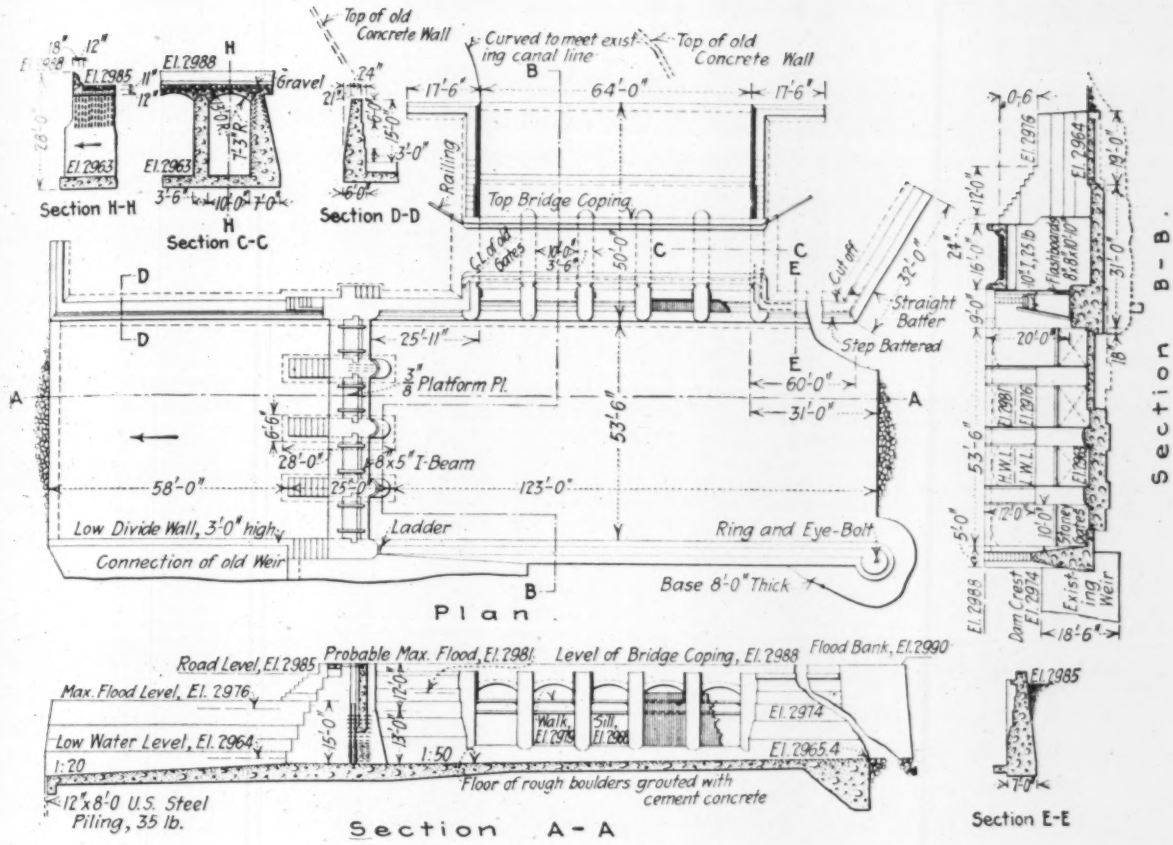

FIG. 2. DETAILS OF NEW HEADWORKS AT NAMAKA DAM

just sufficient. In consideration of uplift on the floor beyond the canal head, the floor is carried down to solid ground and should therefore be free from any hydrostatic pressure; in case any did exist, the 10 ft. thickness of this floor is more than ample.

This work successfully withstood the record flood of June, 1915, which wrecked the weir. In all works which are founded on the porous material that composes the bed of a river and which are also exposed to the dynamic action due to the momentum of floods of high velocity, weight is recognized as a desideratum; for this reason light reinforced-concrete construction is not suitable. Consequently in this design reinforcement has been sparingly used, the thickness given to the piers and walls being such as to render it unnecessary. Steel reinforcement is used in the thin breast wall of the weir sluices and as ties in the arches of the intake and a few other places. A highway bridge is provided across the canal head with proper concrete curbs and parapets, a refreshing contrast to the sorry makeshifts too often adopted for cross-communication. It is noticeable that sheet piling is nowhere made use of; the reason for this is that the river bed contains large-sized hidden boulders that render the driving of sheet piling impracticable except for shallow depths.

Failure of Dam on Porous Foundation

The diversion weir across the Bow River is composed of two lengths, each about 500 ft., separated by an island. The main current of the river is on the south section—that adjoining the canal head. It was in this part that the failure took place. In the article of Feb. 6, 1913, the faults inherent in the design of the section were commented on and it was stated that it only needed either a very high flood or a very low stage of the river to bring about a catastrophe, the correctness of which forecast has now been definitely proved. The main fault in the design consisted in stepping up the foundations of the weir in conformity with the profile of the river bed. This procedure, though suitable enough for a foundation of solid rock, is clearly inapplicable where the river bed consists of loose material liable to erosion. In the river

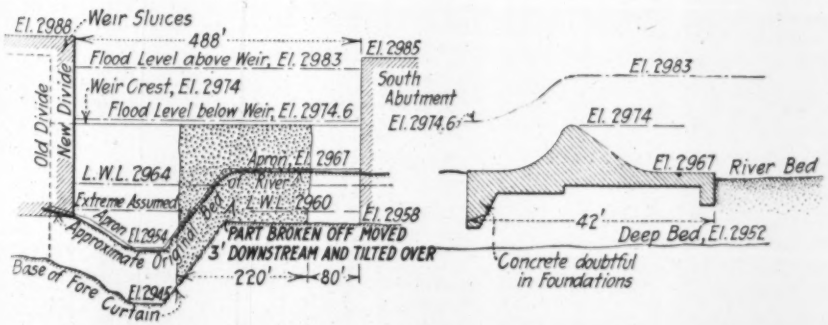

FIG. 3. SECTIONS THROUGH MAIN DAM AT HEAD OF IRRIGATION CANAL

channel in its natural state one part of the bed is deeper than the rest and in this the main current flows. When, however, a level-crested artificial obstruction, as a diversion weir, is thrown across the river, the previous inequalities in the current are obliterated and the tendency of the falling water is to disintegrate and wash away the higher parts of the bed, which are the most exposed and the least protected by a deep stratum of water. Thus the foundation of any overfall dam built on a loose material, as sand, gravel or boulders, must necessarily be at one low level throughout. The violation of this self-evident axiom, combined with insufficient base length, was the cause of the failure.

Fig. 3 is a longitudinal section of the south weir drawn to an exaggerated scale, and adjoining is the minimum section of the weir, which extends for nearly half the length of the work. At the north end the relative positions of the old and new scouring sluices are shown. The flood rose to El. 2983, 9 ft. above the crest of the weir, while the tail water stood at 0.6 ft. above it. The hydrostatic conditions were therefore most unfavorable. The whole of the weir being submerged, its effective weight was reduced by flotation by nearly one-half at a time when a violent flood 9 ft. deep was pouring over the crest. This torrent must have speedily scoured out the unprotected river bed in front of the short fore-apron, in the meantime the hydraulic gradient being reduced to about 1 in 3.8, undermining by the undercurrent had set in and was further assisted by the pressure of the flood waters acting against the weakened resisting ability of the weir. The inevitable result was that the portion most affected, 220 ft. long, sank and fell over, breaking away from the rest, as shown on Fig. 3.

The broken part settled 3 ft. at the time of the accident and swung several feet downstream, toppling forward very much in the same manner as the case of the canal intake. The probability is that the whole of the south weir will have to be demolished and a properly designed hollow-slab buttress dam substituted.

The new headworks were designed by R. G. Kennedy, formerly Chief Engineer of Irrigation Works in the Punjab and well known to the profession from his researches in the matter of the silt-carrying capacity of canals. Mr. Kennedy, now resident at Sidney, B. C., is Consulting Engineer to the company, while the Chief Engineer in active charge of the whole project is D. M. Hays, an American engineer who was appointed when the staff was reorganized after the first failure in 1913.

Two Buildings Carried Over a Railway Tunnel

To carry a four-story building over the tunnel of the Panhandle Route under Pittsburgh, Penn., a steel and concrete box was constructed around and above the tunnel masonry during the past summer. This construction not only provides in safe and substantial manner for the wall, floor and column loads of the building, but makes possible a future widening of the tunnel. The new concrete walls or piers which support the building are now outside the tunnel masonry, but in case of such widening they become the tunnel walls and the old walls and arch inside would be removed.

The tunnel, built during 1863-1865 by the Pennsylvania R.R., is a double-track structure 1,490 ft. long, composed of rough masonry walls and an arch partly of stone block and partly of five rings of brick. It is not far below ground surface, but the original depth of cover (ranging up to 30 ft.) has been greatly reduced by successive street-lowering work done by the city. At Sixth Ave. there was formerly 15 to 20 ft. of cover, while now there is only 7 ft. An old two-story building on the east line of Sixth Ave. rested on shallow footings in the backfill earth over the tunnel—the tunnel having been built cut-and-cover at this point. In replacing it by a new four-story building, new foundations had to be provided not resting on or over the arch.

The section, Fig. 1, shows the design of the new supporting structure, comprising heavy concrete walls along either side of the tunnel, just outside the old tunnel walls, and a roof of steel girders and beams with concrete filling. The framing of these beams is affected by the sharp skew of the tunnel with respect to the street line, as shown by the plan, Fig. 2. Heavy plate girders span from wall to wall on the side lines of the lot, to carry the side walls of the building, and another girder is framed into one of these to carry the front wall. The roof beams vary in size and spacing to provide for columns of the building. Two of them are 27-in. box girders. The roof had to be shallow to save headroom in the basement of the building.

The concrete footing walls at their ends are enlarged into piers capped with grillages to take the reactions of the main girders. Distributing grillages along the top of the walls take the load of the roof beams.

This carrying structure was built in excavation from the surface. Each wall was constructed in a sheeted trench sunk alongside the tunnel wall, with braces across the trench to take the full arch thrust. The bottom

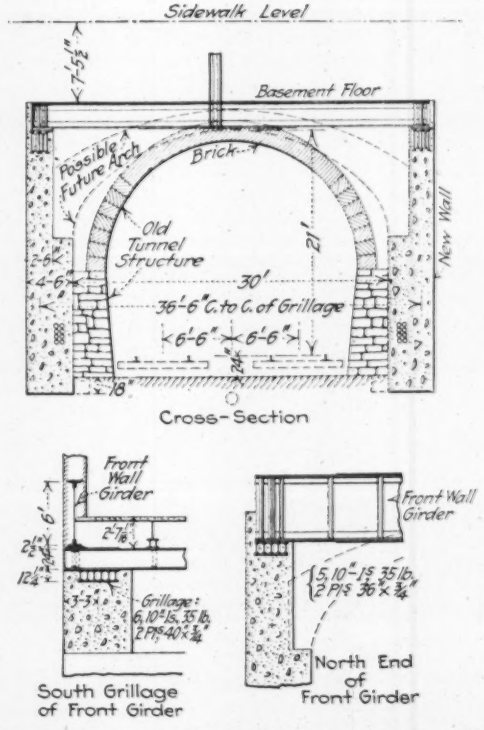

FIG. 1. SECTION OF PITTSBURGH TUNNEL WITH STRUCTURE TO CARRY BUILDING

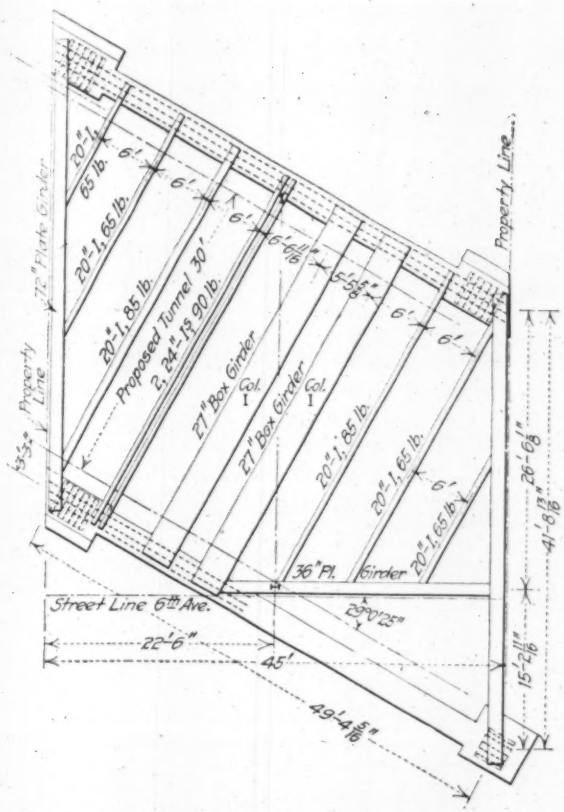

FIG. 2. PLAN OF ROOF FRAMING OVER TUNNEL TO CARRY WERDER BUILDING

of the tunnel is in hard blue limestone, and the masonry of the old walls is laid up on this without widened footings. The new walls were carried down 18 in. lower, and for this purpose the rock was chipped out by hand, as blasting might have disturbed the old masonry.

Placing the roof steel and concreting it was an ordinary operation. The roof constitutes the basement floor of the building.

The John F. Casey Co. did the work for the Pennsylvania Lines, Southwest System. W. C. Cushing, Chief Engineer, Maintenance of Way, directed the work; Frank L. Miller was in charge on the ground. The work was begun in July and completed in September, 1915.

The site of the new Gazette-Times Building, corner of Strawberry Way and Dante Alley, projects over the tunnel from one side a distance of about 14 ft. For this case another method of support was adopted—namely, cantilevering out over the tunnel, so as to keep the building independent of the tunnel structure. C. O. Gilbert was engineer for the work, acting for Edward B. Lee and J. P. Piper, associated architects of the building.

At the projecting corner a large cantilever girder supported on piers and anchored down carries the forward columns. There are two other cantilevers, with smaller amounts of projection. The girders occur at press-room level only and carry columns which support normal floor framing at the tiers above.

The support of the large cantilever is a concrete pier carried down to the level of the tunnel floor. The girder is twin, with flange tie-plates. The rear column, which furnishes the anchorage, does not pass through the girder, but the upper section starts from the top flange of the girder. The column below the girder takes the uplift by way of an anchor plate riveted to the back of the end stiffeners of the girder. As this column has not enough dead-load to balance full live-load on the front column, it is anchored down to its concrete footing pier, and this pier is made larger than otherwise required and is belled out in the rock.

The Fort Pitt Bridge Works built the steelwork of the Gazette-Times Building.

City Paving Compared with Contract Work

The cost of street work done in St. Paul, Minn., by city forces on a number of jobs shows a considerable saving over contractor's bids, according to figures given recently by Adolph F. Meyer, Consulting Engineer, St. Paul, in the "Bulletin" of the Civil Engineers Society of St. Paul. The table is reproduced herewith. It shows lower cost of work by the city in nearly every individual instance; for the total of all the jobs in the table the city work is about 10% cheaper.

The table of contract figures is not the bid price itself, but the bid price plus 3%, the author of the article having added this to cover the cost of inspection. Were the 3% not added, the showing of the table would be but slightly changed. Mr. Meyer concludes: "The experience of 1915 shows that on the whole there is not likely to be any saving to the city through the letting of paving work by contract instead of doing it by force account, unless the lowest bid received is at least 7% less than the engineer's estimate."

COST OF FORCE-ACCOUNT PAVING, ST. PAUL, MINN., 1915

Street	Actual Cost	Engineer's Estimated Cost	Contfactor's Bid Price	Saving on Engineer's Estimate	Saving on Contractor's Bid Price	Percentages: Engineer's Estimated Cost Is Higher Than Actual Cost, %	Percentages: Contractor's Bid Price Is Higher Than Actual Cost, %
Fillmore Av.	$10,056.06	$11,441.00	$11,401.48	.....	$1,345.42	13.78	13.38
Robert St.	11,732.29	12,266.75	14,445.50	.....	2,713.21	4.6	23.00
Fairfield Ave.	25,570.42	28,112.00	28,461.99	.....	2,891.57	9.9	11.3
S. Smith Av.	34,265.98	38,012.00	37,530.00	.....	3,264.02	11.0	9.5
Fairview Av.	3,825.78	4,121.00	4,793.60	.....	967.82	7.7	25.3
Linwood Pl.	3,375.54	3,485.68	4,512.43	.....	1,136.89	3.2	33.0
Wabasha St., Winnifred St., Ohio St., George St.	42,101.03	45,734.77	50,565.45	.....	8,464.42	8.6	20.1
3rd St.	3,951.18	3,839.13	4,031.55	.....	80.37	−3.0	2.0
Robert St.	7,016.75	7,460.00	7,236.78	.....	220.03	6.3	3.1
Summit Av.	3,364.85	4,000.00	3,799.67	.....	434.82	19.2	13.0
Plum St.	1,687.58	1,800.00	1,859.15	.....	171.57	6.6	10.2
Congress St., Isabel St., Concord St.	15,710.32	17,394.52	18,227.39	.....	2,517.07	10.7	16.0
Dayton Av.	17,581.89	20,817.00	20,208.60	.....	2,626.71	18.4	14.9
N. Smith Av.	57,636.92	61,228.88	63,270.72	.....	5,633.80	6.23	9.78
Marshall Av.	96,253.82	107,247.00	104,025.88	.....	7,772.06	11.4	8.08
Total	$334,130.41	$366,959.73	$374,370.19	$32,830.12	$40,239.78	9.83	12.04

State-Wide Clean-Up of Labor Camps in California

By J. J. Rosenthal*

SYNOPSIS—Through the efforts of the Commission of Immigration and Housing many labor camps have been reconstructed along sanitary lines and nearly 1,500 camps housing almost 100,000 people have been inspected.

On Aug. 3, 1913, a riot occurred on the Durst ranch near Wheatland, Yuba County, Calif., resulting in the killing of two hop pickers and two police officials. Upon investigation by state and Federal officials, it was found that the primary causes of the discontent in the ranks of the hop pickers, leading up to the riot and bloodshed, were the insanitary conditions of the camp. The writer, who was one of the investigators in the field, obtained affidavits testifying to the following facts:

In 1913, the Durst Brothers, by means of widespread advertising throughout the State of California, succeeded in assembling a polyglot body of 3,000 pickers, about half of whom were women and children. At the time of the riot there were about 2,800 pickers in the camp. When

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PORTIONS OF OLD AND NEW HOP PICKERS' CAMP, DURST BROTHERS' RANCH, NEAR WHEATLAND, CALIF.
Upper—Hobo camp, 1913; shelters of gunny sack, supported on brushwood. Lower—Model camp, 1914, after plans by Commission of Immigration and Housing

CAMPING IN CROWDED QUARTERS WITH ALL OUTDOORS AVAILABLE

(Left)—A row of 4x6-ft. inhuman stalls in a bunkhouse where 15 to 20 laborers slept; window at rear, only means of ventilation, shut down. (Right)—Two 10x26-ft. triple-deck bunk cars, each occupied by 19 persons, affording 95 cu.ft. of air space each. This was a state highway construction camp until corrected.

this conglomerate body arrived at the Durst ranch, it found a desolate sun-baked field, without shelter from the burning sun of the Sacramento Valley. There were only a few tents which the Durst Brothers rented at 75c. per week; but the majority had to construct rude shelters made of poles and gunny sacks, called "pig pens," while many were compelled to sleep in the open piles of hop vines and straw.

From reports and investigations there were not more than 11 toilets, of the crudest sort, for this number of people, used indiscriminately by both sexes.

There was a scarcity of drinking water on account of the dry season and some of the wells were pumped dry, while others became infected from the surface water that drained back from stagnant pools and the toilets which were in close proximity. Under such deplorable, insanitary conditions, sickness prevailed in the nature of typhoid, dysentery and malarial fever.

While the wage scale and other factors contributed to the feeling of discontent, the paramount cause of the protest of the pickers seemed to be the inadequate and the insanitary conditions, under which the hop pickers were compelled to live.

The Commission of Immigration and Housing decided that these insanitary conditions constituted an aggravation of industrial warfare, and that they could and should be changed at once. It was ascertained that Durst's camp was no exception; for similar conditions existed in other labor camps throughout California, and it was decided that a *state-wide clean-up* campaign was indispensable. This task really came under the jurisdiction of the State Board of Health, but that body was without funds to do the work of inspection and of remedying the conditions. Consequently the Commission of Immigration and Housing, with the consent of the State Board of Health, decided to enter upon this undertaking, particularly because one-half of the population of the labor camps of the state is made up of immigrants.

The existing state law pertaining to the housing of labor camps was found to be inadequate and inefficient. It merely stated in general terms that tents, sleeping quarters, and the grounds about camps must be kept clean. No way was provided for ascertaining the conditions of the camps except through the occasional complaint of a laborer fearless enough to risk incurring the displeasure of his employer. Nor did the statute attempt to set forward a minimum standard of housing and sanitary conditions, which can readily be seen in the following:

Section I. In or at any camp where five or more persons are employed, the bunk houses, tents and other sleeping places of such employees shall be kept in a cleanly state and free from vermin and matter of an infectious and contagious nature, and the grounds around such bunk houses, tents or other sleeping places shall be kept clean and free from accumulations of dirt, filth, garbage and other deleterious matter.

Section II. Every bunk house, tent or other sleeping place used for the purpose of a lodging or sleeping apartment in such camp shall contain sufficient air space to insure an adequate supply of fresh air for each person occupying such bunk house, tent or other sleeping place. The bunks or beds shall be made of iron, canvas or other sanitary material and shall be so constructed as to afford reasonable comfort to the persons occupying such bunks or beds.

TWO TYPES OF IMPROVED CAMPS FOR CALIFORNIA LABORERS

(Left)—Permanent model bunkhouse for farm laborers, with separate well-ventilated room for each man and large 10-shower bathroom. (Right)—Model camp for laborers in oil fields. One of the buildings contains six shower baths and other washing facilities.

Owing to these weaknesses in the foregoing law, the Commission of Immigration and Housing had first to work out a minimum standard of living conditions in labor camps. This minimum standard had to be sufficient to insure results, but not so expensive and so impracticable as to deter employers of labor camps from adopting it, since employers had to be persuaded rather than compelled by law to meet the improvements suggested.

In order that the Commission of Immigration and Housing might be sure of its ground it decided to remodel a camp and make it sanitary, thus putting theory into actual practice. This first experiment of camp sanitation was made at Shingle Springs, El Dorado County, where 135 men were employed by the state on highway construction. The Chief Sanitary Engineer of the Commission planned a model camp, and installed latrines, shower baths, fly-proof cooking and dining tents, model sleeping quarters, garbage receptacles, and incinerators, and other modern improvements at a minimum cost. The results were very satisfactory and a set of sanitation rules was drawn up. These rules and practical suggestions for carrying them out were compiled in a small pamphlet of 7 pages which met with the approval of the State Board of Health.

These pamphlets were distributed among camp owners throughout the state. The Chief Sanitary Engineer and a force of inspectors were sent out. They found that most of the camps were below the minimum standard, but found that the camp owners were willing to coöperate to improve the conditions of their employees, but did not know how to go about the work to make improvements without plans and instructions. Consequently it was deemed advisable to prepare a larger and more comprehensive booklet containing detailed plans, bills of materials, and specifications of camp facilities, taking Los Angeles, Fresno, San Francisco and Sacramento as central points of market price of materials and labor.

Believing that much of the abuse arose more through carelessness and ignorance on the part of those operating labor camps, than because of any disposition to avoid the law, the whole spirit of our efforts was coöperation and advice rather than compulsion.

A pamphlet containing 56 pages and 43 illustrations was prepared and more than 6,500 copies of it have been distributed since it was published in July, 1914. In this booklet it is pointed out that a sanitary camp means an increase in the willingness and efficiency of the laborer, and that it is in the employer's own interest as well as that of humanity to have a sanitary and livable camp. Every phase of camp sanitation and housing is dealt with. Blueprints and sketches of camp structures have been furnished when desired. The suggestions cover the site of camp with advice as to choosing high ground, layout of camp, water-supply, construction of tents, buildings and bunks; screening, ventilation, etc.; kitchens and eating houses, with suggestions for keeping food; disposal of garbage and refuse by means of incinerators; fly-proof toilets; with complete plans and specifications for bathing facilities, sleeping quarters, with proper drainage, and how to avoid camp sicknesses that come from flies, mosquitoes, manure piles, and other causes.

The pamphlet met with the most gratifying response from camp owners throughout California, and hundreds of commendatory letters were received.

Active camp inspection was begun by the Commission on Apr. 1, 1914. Inspectors are sent out into the field, who report their findings to the office on blanks, which give every detail of the camps inspected, including the number and nationality of men employed, permanent or temporary, skilled or unskilled labor, living conditions, sanitary conditions, toilets, bathing and washing facilities, etc. A letter of instructions and a pamphlet are then promptly mailed from the main office to each owner or superintendent of the labor camp, calling attention to the special needs of his camp, and inviting correspondence with the office of the Commission of Immigration and Housing if any difficulty arises in trying to make his camp conform to the requirements.

Up to Jan. 1, 1916, 1,346 camps, housing 91,728 persons, were inspected, 858 of these camps have been reinspected, and 75% have come up to the standard set by the Commission, while the remainder have made some of the suggested improvements.

Some of the conditions before and after the work of the Commission was begun are shown by the accompanying views.

Storing and Pumping Sewage, Manchester, Mass.

By Charles W. Sherman*

The town of Manchester, Mass., is situated on the southerly side of Cape Ann, with the thickly settled portion of the town at the head of Manchester Harbor, a narrow bay about 1¼ mi. long. The area served by the sewers is about a mile square, and the most congested portion of it is but little above the level of high tide. Some of the sewers are laid on flat grades, and the highest practicable invert elevation of the sewers at the location selected for a pumping station upon the shore of the harbor was —1.75, datum being mean low water. As the range of tide averages about 10 ft. and extreme tides rise to about El. 13, it is evident that a gravity outlet would have involved serious backing up into the sewers at each high tide, even if it were allowable to discharge sewage into the harbor. The point selected for discharge was, however, in deep water off the mouth of the harbor, at a distance of some 8,500 ft. from the pumping station and where there is a depth of about 40 ft. at low water. It is believed that many years will elapse before the quantity of sewage to be produced in Manchester—a town of 2,945 inhabitants in 1915—can be noticeable at the outlet.

As the amount of sewage to be cared for is not great and as it is not desirable to pump continuously, storage tanks were necessary; and as these tanks have their tops more than 10 ft. below the level of extreme high water, it is obvious that stability against floating when empty had to be taken into consideration, as well as strength to carry the considerable earth-fill (about 12 ft.) over the roof. These conditions resulted in some details of design not usual in structures of this character.

The subterranean structure consists essentially of three parts: (1) a screen chamber, (2) the two storage tanks, (3) a dry well for the pumps—all as shown in detail by the accompanying plans and sections.

*Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

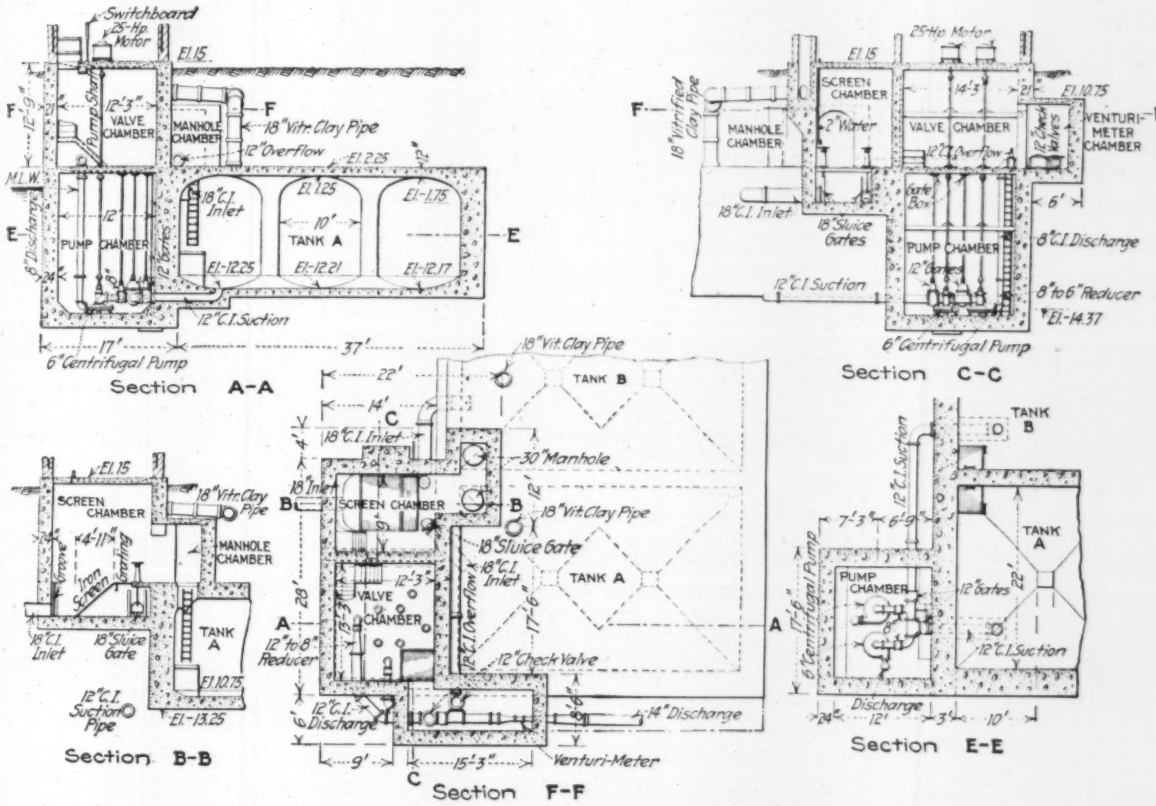
The screen chamber, which is reached by an iron stairway from one end of the brick superstructure, contains an inclined rack of iron bars, and gates by which the flow of sewage may be shut off from either tank if desired. The entrance to the tanks is from the screen chamber by manholes in the roofs of the tanks. A portion of the floor of the screen chamber is of iron bars, to facilitate draining the screenings. There is an overflow connection from the screen chamber into the force main, so that if the pumps should be out of service the sewage would overflow after reaching El. 2.50, except when the tide is at a higher elevation.

The storage tanks are two in number, either or both of which may be used. Each tank has an available capacity of about 55,000 gal. The groined-arch type of construction was adopted for both roof and floor. Each bay has a clear span of 10 ft., and the piers are 2 ft. square. The rise of the arch is 3 ft. and the thickness of roof 12 in. Each tank consists of three bays in length by two in breadth and therefore measures 22x34 ft. in plan, the effective depth being about 11 ft. and the columns 9 ft. high. The division wall between the tanks is 2 ft. in thickness, and the side walls are 3 ft. thick.

Iron ladders are provided in the manholes and also iron platforms from which it is possible to wash down the walls of the tanks by a hose stream. Since the volume of air displaced as the tanks fill is considerable and it was not desirable that this should be forced up through the manholes and the screen chamber, a chimney containing a large ventilating flue (18x36 in.) was built at one end of the superstructure; and an 18-in. vitrified pipe flue from each of the tanks leads to the bottom of the chimney.

The pump chamber is a dry well at the end of the tanks and adjoining the screen chamber. The pumps are set below the bottom of the tanks; and as shown in the plan, either or both of the pumps can draw from either or both of the tanks. Leakage or condensation in the dry well drains to a small sump, from which it can be lifted by the main pumps by opening a 1½-in. angle valve operated from the floor above.

The floor above the pump chamber forms a room called the valve chamber. Here are located the gate valves on the discharge pipes, and all of the valves on the suction connections are operated from this floor by extension stems reaching to gate boxes set in the floor. An iron ladder extends from this floor down into the pump chamber. A small chamber leading out of the valve chamber contains the check valves on the main discharge and overflow pipes and also the venturi meter. The pumps are electrically driven, the motors being in the superstructure.



DETAILS OF SEWAGE STORAGE TANKS AND PUMPING STATION, MANCHESTER, MASS.

The pumps are of the ordinary type of open impeller vertical centrifugal pump and were furnished by the Lawrence Machine Co.

The Sewer Commissioners under whose direction this work was carried out are Oliver T. Roberts, George E. Cabot and James Hoare. The Chief Engineer was Raymond C. Allen, of Manchester. Desmond Fitz Gerald, of Brookline, was Consulting Engineer, and the storage tanks and pump well were designed under his direction in the office of Metcalf & Eddy, of Boston.

The structure was built in 1914 by the Charles R. Gow Co., contractor, the price being $15,300, including superstructure, but not including cement, bricks or ironwork, which were furnished by the town.

Concrete Viaduct with Special Expansion Provisions

By Charles W. Martin*

The Jefferson Ave. viaduct built by the City of St. Louis, Mo.—a long reinforced-concrete viaduct made up of a series of girder-and-slab spans—is somewhat novel in that expansion is provided by dividing some of the pedestals in two by a vertical opening. The viaduct is otherwise distinguished by the method of placing the coping and by the design of the railing and the light posts.

The viaduct, which replaces an old one of steel, is 1,255 ft. long, extending from Scott Ave. to Chouteau Ave., and spans Papin St. and the tracks of the Missouri Pacific, Wabash and Frisco railways. It is 60 ft. wide and provides a 40-ft. roadway and two 10-ft. walks.

The bridge structure over the tracks consists of 14 spans, varying in length from 31 to 45 ft., with two end abutments and 13 piers, and skewed to meet track conditions. In general, each pier consists essentially of three vertical shafts 2x8 ft. in plan and resting on a transverse foundation slab. The principal structural elements of each of the 14 span units of the superstructure are 10 longitudinal stringers, two transverse end beams and a 12-in. slab. The two abutting end beams of adjoining spans are, save at expansion joints, keyed together over the piers with a saw-tooth arrangement of the transverse construction joints. No negative reinforcement is extended across this joint, as it was considered that the character of the foundation precluded all other than a simple beam-type deck-span design. This is shown in the upper detail in Fig. 3.

*Engineer, Bridge Division, City Hall, St. Louis.

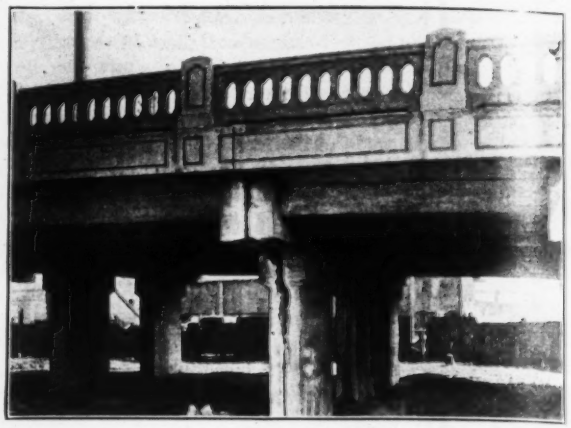


FIG. 2. ONE OF THE SPLIT PIERS TO TAKE CARE OF EXPANSION

The bridge over Papin St. has a center roadway span of 25 ft. and two 8-ft. sidewalk spans that are supported by two abutments and two lines of piers along the curbs.

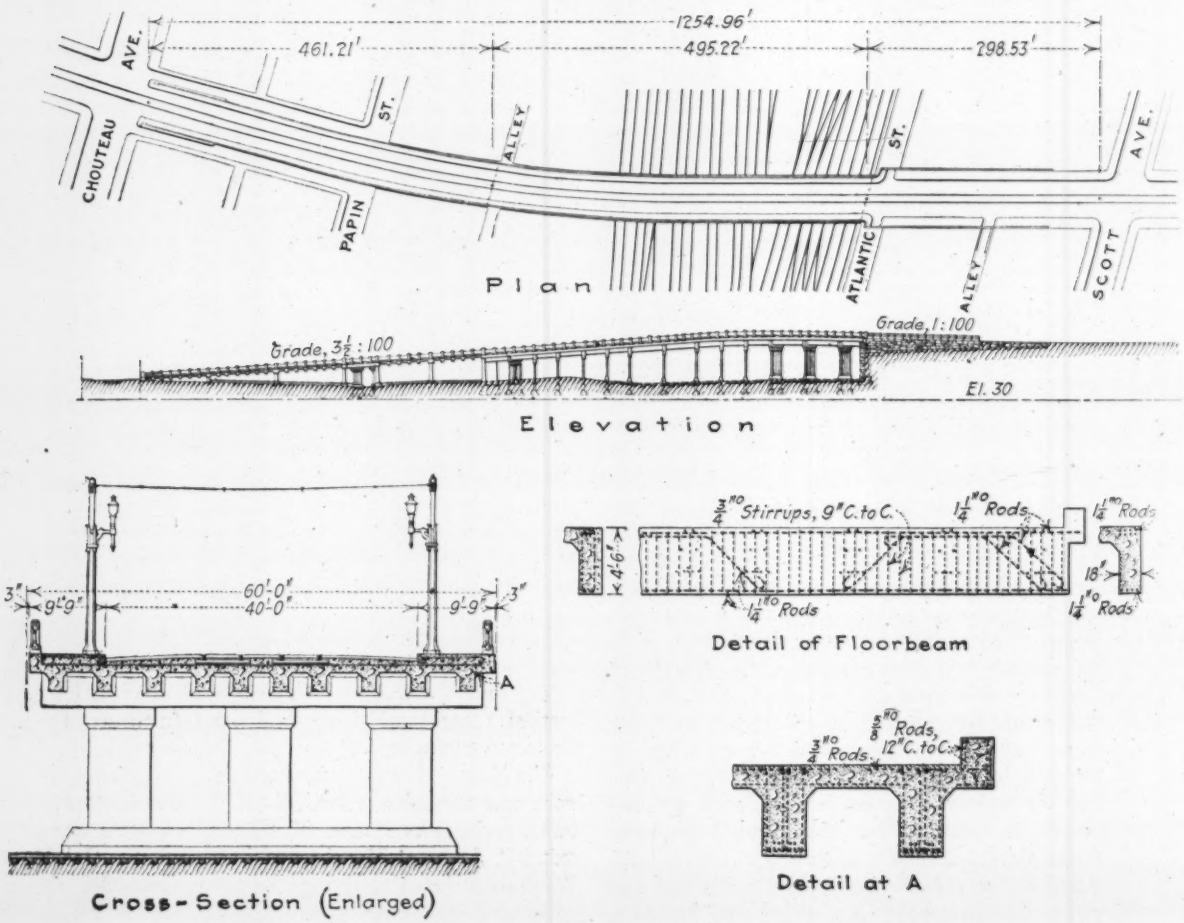


FIG. 1. DETAILS OF JEFFERSON AVE. VIADUCT AT ST. LOUIS, MO.

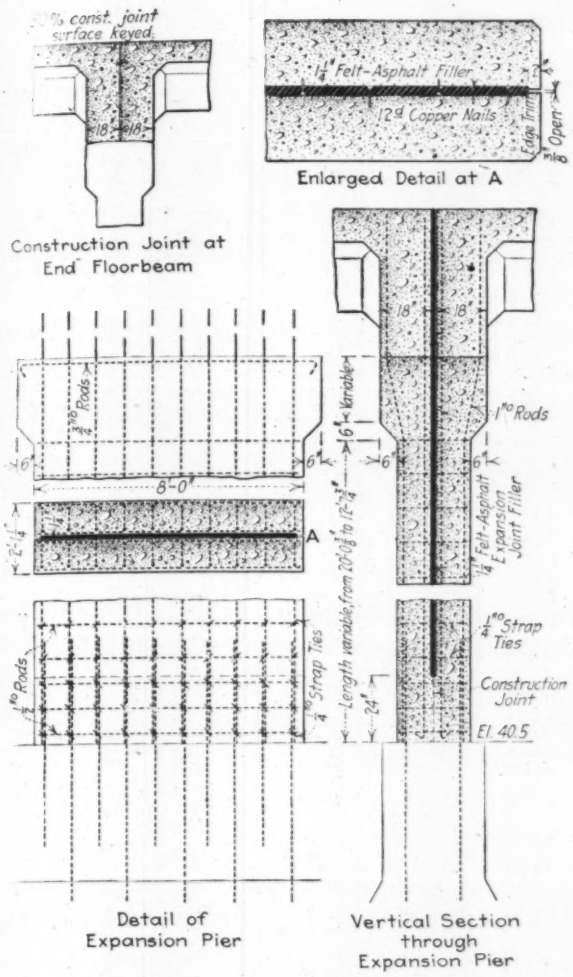

Construction Joint at End Floorbeam
Enlarged Detail at A
Detail of Expansion Pier
Vertical Section through Expansion Pier

FIG. 3. DETAILS OF AN EXPANSION PIER, JEFFERSON AVE. VIADUCT

The top surfaces of the deck slabs are flat and 12 in. below the street grade. At each side the slabs are flanked with copings that extend 15 in. above the slab to the sidewalk grade and carry the bridge railing. Over the slabs the roadway, walk, curb and car-track construction are laid as on a street. This arrangement augments the dead-load and consequently increases the cost, but it offers numerous construction advantages and provides space for conduits, pipes, etc.

Provision for Expansion

The bridge structure over the tracks is 495 ft. long. With the usually assumed temperature range and expansion coefficient, a distortion (expansion or contraction) of 1¼ in. might be computed for a concrete piece of that length. Frequently, movable bearings of iron or steel at intervals of from 100 to 200 ft. are used to provide for such distortions in long concrete bridges. In this structure a type of expansion joint is employed that obviates the necessity for such bearings. It consists of an arrangement of split pier shafts that, by flexure, make adjustment for the temperature distortions.

At four pier lines in the bridge structure the three vertical shafts of each pier are constructed as two independent halves, of 1x8-ft. horizontal section, with an elastic membrane 1¼ in. thick interposed. The end beams of the deck-span units abutting at these piers are also separated from each other, from out to out, by a like membrane and are each supported independently by a set of three of the half-sectioned shafts. The elastic membrane employed is a combination of felt and asphalt. The membrane is anchored to the concrete on each side of it with copper nails, and at the concrete faces the edges are finished with a trim showing only a ⅜-in. joint.

When the outside face or coping of a concrete-bridge span is cast integrally with the deck structure, settlements in the centering generally prohibit the attainment of good lines and grades. For that reason the copings in the Jefferson Ave. bridge were cast as a mask along the outside edges of the slabs after the deck structure was completed. The projection of the coping below the slab was an important feature in the attainment of good facial lines. It will be observed from Fig. 2 that the panels of the railing do not necessarily coincide with the bridge spans; that is, the railing posts are not just above the piers.

The railing posts and also the facia coping of the bridge structure are paneled with red terra-cotta tile inlays. These tiles were fastened in the forms with copper wire and the concrete cast around them. In order to prevent the discoloration of the tile face by the absorption of the watery grout which percolated between the tiles and the form boards the face of the tile was waterproofed with a solution of paraffin and naphtha.

A system of concrete poles at intervals of approximately 100 ft. along each curb line carries the bridge lights and the overhead wiring of the street railway. Each pole is reinforced with four full length 1¼-in. diameter bars and No. 10 wire hooping at 3-in. pitch. For the poles on the bridge deck the 1¼-in. bars were upset and threaded and extended 2 ft. beyond the butt end. As the poles were erected, these bars were dropped through pipes in the deck-slab concrete and anchored below with washers and nuts. End tenons 15x15 in. in section and 4 ft. 6 in. long were cast as an integral part of the poles, which were set on the earth embankments of the approaches. In erecting these the tenoned ends were dropped into mortised concrete foundations and grouted in place. The top cap, to which the trolley wires are tied, and the light brackets are of bronze. The light wires are carried

FIG. 4. VIEW ALONG JEFFERSON AVE. VIADUCT, SHOWING SPECIAL RAILING AND LIGHT POSTS

through the poles in 2-in. diameter "sherardized" pipe and along the bridge in 3½-in. diameter fiber conduits under the walks (Fig. 4).

The concrete in the railings and poles was made with gray granite aggregate graded down from a ½-in. maximum size. The proportions of the mix were 1:3 for the railings and 1:2½ for the poles, and 1% by weight of Medusa waterproofing compound was added to the cement for both. The surfaces were given a scrubbed finish, which slightly exposed the granite aggregate.

Heman Construction Co. was the contractor for the removal of the old bridge and the construction of the principal structural elements of the new one. All concrete, save that for the Papin St. span and the walls along the approaches, was handled from a mixer situated just south of the railway tracks. The sand and gravel were handled direct from cars to bins, situated over the mixer, by a derrick and clamshell bucket. The concrete was discharged into bottom-dump buckets mounted on trucks, pushed out by hand and picked up and carried by a 600-ft. span Lambert cableway to movable receiving hoppers. From these hoppers the concrete was distributed by chutes.

The cost of the viaduct complete was approximately $94,000. E. R. Kinsey is President of the Board of Public Service. L. R. Bowen is Bridge Engineer. The writer designed the structure.

Tests of Backing for Flexible Concrete River Mattress

By B. Okazaki*

SYNOPSIS—Method of river protection by means of small concrete blocks knitted into mattress by steel wire, described by Mr. Okazaki in "Engineering News," May 16, 1912, p. 922, Mar. 13, 1913, p. 512, June 25, 1914, p. 1405. This article recounts tests on various methods of backing so as to prevent percolation of water and consequent leakage of soil from under the mattress.

The flexible concrete mattress for river bank protection as placed in the Ishikari River district of Japan has two variations: Where the mattress is set in shallow water it is usually placed at once for its full width; where it is set in deep water it is placed in minimum width and is afterward supplemented by additional width when the scouring of the river bed in front of the mattress goes on. This addition of width is continued until the stream-side edge of the mattress reaches its destination, the bottom of the thalweg.

There is no reason to worry about any leakage of the soil through the interstices of the mattress when the scouring of the river bed in front is going on and the mattress is sinking down to follow the scoured new river bed. However, this leakage of soil is not welcome after the stream-side edge of the mattress has reached the bottom of the thalweg, as in the second case, or when the mattress is at first laid in full width, as in the first case, because then the stability of the mattressed bank is desired.

Soil such as gravel or tough clay does not scour or leak through the interstices of the mattress under ordinary circumstances, although there is a ¾-in. joint between adjacent vertical ends of blocks, but sand, lacking any coherence, is liable to leak through the mattress unless some proper lining, such as a fascine mat, is provided beneath the mattress. Such a lining as is shown in Fig. 1 has often been used, particularly when the sand is fine-grained.

In order to arrive at some basis for the design of such a lining or backing, the author made experiments on several kinds of lining that can be made of materials at his disposal and at a moderate cost. He assumed that on the bank with a given slope, the amount of leakage is in a certain way proportional to the velocity of river current just in front of the mattress and inversely proportional to the thickness of the permeable materials that compose the lining. To test the soundness of these assumptions, he made the experiments in four ways, as follows: (1) On a bare flexible concrete mattress with no lining; (2) on the same mattress with a layer of gravel 0.3 ft. thick and of grains from 0.08 ft. to 0.02 ft. diameter; (3) with a layer of wire knit fascine mat 0.35 ft. thick and (4) with double layers of the same fascine mat 0.35 ft. thick.

For the tests an experimental channel, shown in Figs. 2 and 3, was built. This channel consists of wooden-plank open conduits 60 ft. long, 6 ft. wide and 6 ft. deep, provided in the tailrace with a silt basin and an overflow weir the crest of which can be adjusted to any required height. An underground stave pipe 2 ft. square and 96 ft. long leads from a barge canal to an upper basin of the experimental channel, there being a regulating gate at the entry end of the stave pipe. On one side of the experimental channel is formed an artificial sand bank with an intended slope on which the mattress and the lining are laid.

The flow is adjusted by means of the entrance regulating gate and the height of the crest of the weir. The velocity of flow in the experimental channel is regulated by changing the discharge and by changing the width of the slit or pass formed between the experimental mattress

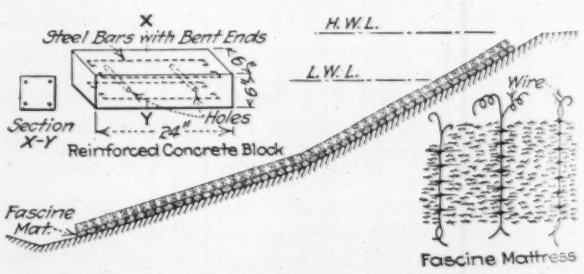
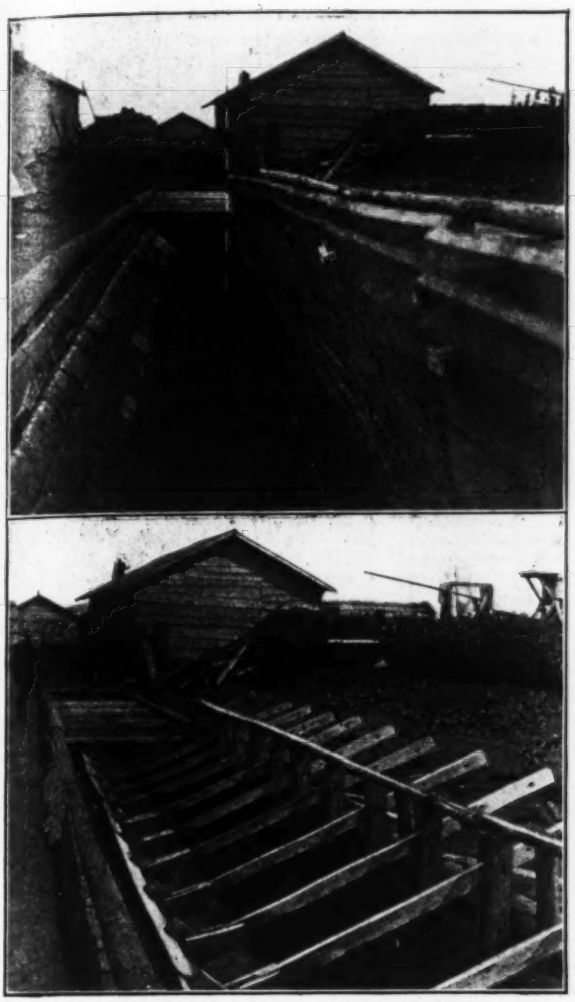


FIG. 1. FLEXIBLE CONCRETE RIVER-PROTECTION MATTRESS WITH FASCINE MAT BACKING

*Chief Engineer, Ishikari River Improvement Works, Sapporo, Japan.



FIGS. 2 AND 3. EXPERIMENTAL FRAME TO TEST RESISTANCE TO SILTING

Fig. 2 (Upper)—With lid turned up and mattress exposed
Fig. 3 (Lower)—With lid turned down against mattress

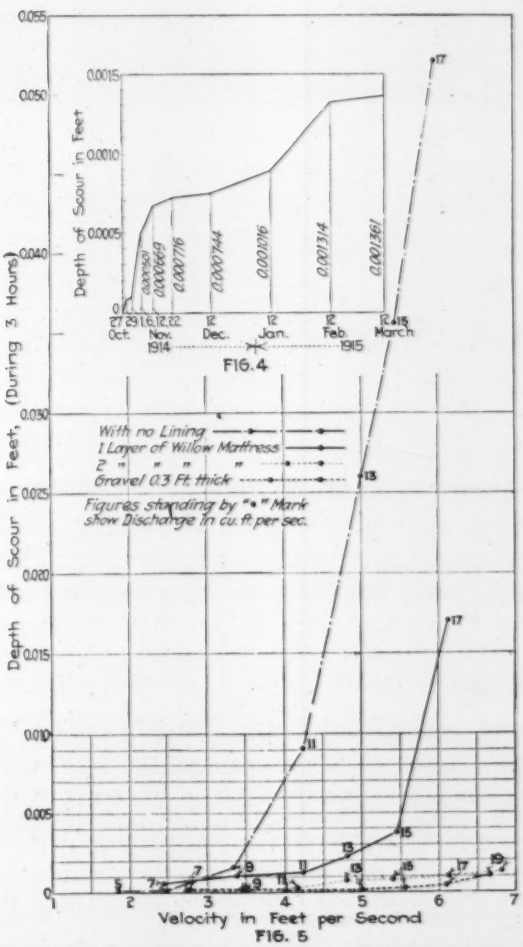
set on a sand slope of a given grade and a movable longitudinal lid or gate hinged to the foot of a side wall of the channel. Thus a given discharge divided by the corresponding cross-sectional area of the slit gives the average velocity of the current. The lid is kept at any desired inclination parallel to that of the opposite sand slope on which the mattress and the lining are laid, by simply turning it around the hinge by means of handles. In the experiments the velocity of flow was made to vary from 1 ft. per sec. to 7 ft. per sec. and the slope of 1.15 horizontal to 1 vertical was adopted.

The sand leaking through the mattress is deposited in the silt basin, allowing only water to overflow the weir. The sand deposited during one stage of experiment (usually 3 hr.) is collected from the bottom of the silt basin after emptying the water in the channel and the silt basin, and its volume is measured. The total volume of the sand divided by the total area subject to the scouring action gives the average depth of scour, and this depth converted into equivalent for 3 hr. is plotted as ordinate and the corresponding velocity as abscissa, as in Fig. 5. The long-time experiment with a lining made of a single layer of fascine mat 0.35 ft. thick was continued for several months for a velocity of 4 ft. (see Fig. 4).

The sand forming the slope in the experiment is taken from the river bank in the vicinity of the site of the Ishikari River improvement works at Bannaguro and its specific weight is 2.65, its grains varying from 0.005 ft. to 0.001 ft. in diameter. The gravel, which is rather small-grained, varying from 0.08 ft. to 0.02 ft. in diameter, is used to make 0.3 ft. thick lining.

Willow sticks not greater than 0.1 ft. in diameter are used for mat making, the mat being knit with No. 15 galvanized wire at 1½-ft. intervals, as shown in Fig. 1, the thickness of a layer of mat being 0.35 ft.

We may conclude from the results of the experiments that: (1) With no lining there is remarkable leakage beyond the velocity of 3½ ft. per sec.; (2) with a single layer of the fascine mat 0.35 ft. thick, there is a remarkable leakage beyond the velocity of 5½ ft.; (3) with double layers of the fascine mat there is no appreciable leakage even for a velocity of 6½ ft.; (4) with gravel lining 0.3 ft. thick there is the least leakage; (5) with a single layer of the fascine mat the long-time experiment shows that with a velocity of 4 ft. there is no uniformity in the rate of leakage and the depth of scour does not amount to 0.0015 during 135 days; (6) sand-tight lining can be made with either double layers of fascine mats 0.35 ft. thick or a 0.3 ft. layer of gravel whose grains vary from 0.08 ft. to 0.02 ft. in diameter when the velocity of current does not exceed 6 ft.



FIGS. 4 AND 5. DIAGRAMS SHOWING SCOUR FOR DIFFERENT VELOCITIES AND DIFFERENT KIND OF BACKING

Public-Works Accounting for Villages and Towns

By Charles A. Holden*

The efficient management of municipal affairs requires carefully kept records, the minuteness of detail depending upon the outlay which the amount yearly expended will justify. This is a matter of importance for villages as well as cities, but perhaps more often overlooked by the smaller places than the larger.

COMMISSIONERS OF THE VILLAGE PRECINCT OF HANOVER, N. H. ORDER NO. 499

AUDITED ..... AMOUNT $ .....

APPROVED BY ..... PAYEE .....

DATE 191

DISTRIBUTION OF EXPENDITURES

MAINTENANCE				CONSTRUCTION AND IMPROVEMENTS				
ACCT NO	ACCOUNT CHARGED	AMOUNT	KIND OF WORK	ACCT NO	ACCOUNT CHARGED	AMOUNT	KIND OF WORK	REMARKS
	STREET DEPARTMENT			57	STREET DEPT. Pipe Drains & Manholes — Trunk Line / State Aid / Other			
	..... St.							
1	Cleaning & Repairs — Trunk Line / State Aid / Other			58	Road Foundation and Surface — Trunk Line / State Aid / Other			
2	Sweeping			59	Cross Walks			
3	Sprinkling			60	Equipment (Mchy. & Tools)			
4	Oiling			61				
5	Removing Snow			62				
6	Snowing Bridge			63				
7	Rolling Snow and Breaking Roads				FIRE DEPT.			
8	Sanding Walks			64	Equipment			
9	Repairs to Equipment				POLICE DEPT.			
10	Replacement of "			65				
11	Stone Crusher—Operation				PRECINCT HALL PROPERTY			
12	" Repairs and Replacements			66				
13	Materials & Supplies—Stock			67				
14	Trees and Shrubbery				Other Construction			
15				68				
16	Work or Supplies Outside Parties							
17	Miscellaneous				WATER DEPT.			
	STREET LIGHTING				HEALTH DEPT.			
	FIRE DEPT							
	POLICE DEPT				Total			
	WATER DEPT				SUMMARY OF DISTRIBUTIONS			
	HEALTH DEPT				Maintenance			
	PRECINCT HALL PROPERTY				Construction & Improvement			
	DEBT—Principal				Previously Distributed			
	" —Interest				Total			
	GENERAL			*F—Freight L—Labor M—Materials R—Repairs S—Services T—Teams				
	TOTAL							

STATEMENT

DATE WEEK ENDING	AMOUNT
Amount brought forward	
To date being	
TOTAL	

COUNTERSIGNED:

..... COMMISSIONER

..... COMMISSIONER

COMMISSIONERS OF THE VILLAGE PRECINCT OF HANOVER, N. H

ORDER No. 499

HANOVER, N. H., ... 191

DARTMOUTH NATIONAL BANK

OF HANOVER, NEW HAMPSHIRE

PAY TO THE ORDER OF ..... $ .....

..... DOLLARS

IN PAYMENT OF BILLS AS PER STATEMENT ANNEXED.

..... TREASURER

FIG. 1. VOUCHER CHECK, WITH DISTRIBUTION STUB, HANOVER, N. H.
Original, 8⅜x11 in., on blue paper

Unless one has studied the subject with care, he does not realize the expenditure for record keeping which will be repaid by the resulting efficient management and the prevention of leaks. Just as soon as one begins seriously to keep records he begins to study more carefully the costs and to plan operations far in advance, that they may be done economically and harmoniously. He studies the seasonal effects on the cost of construction and many other phases of the subject to which he had previously given no consideration. For example, he notices that trenches for drain pipes can be laid before the [illegible] heat of the summer with a labor cost much less [illegible] in the summer. He buys material in the lowest [illegible] takes advantage of cash discount, uses more care [illegible] see that materials and tools are kept in a central and [illegible] location instead of lying scattered around where they deteriorate rapidly and are perhaps lost altogether. He realizes that it is not economy to expend labor for [illegible] borrowing a tool and making repairs on it equal to perhaps three-quarters of what the tool would cost new, with the result that when the work is done there is no equipment to show for the expenditure, whereas if the tool had been bought new, seven-eighths of the value of the expenditure would have been added to assets. Neatness, orderliness, thrift and improvement spread contagiously in any locality where the village authorities practice them in village affairs. The reverse is true also.

One does not go very far in such records without a keen appreciation of the value of, and necessity for, a good superintendent who will see that full value for money paid will be rendered by teams and labor and that it is wasteful to turn the work over to a man with no peculiar training for the work, especially if he is to be in charge for only a year or two and is then to be succeeded by a new man who must begin the same or similar experiments with the same or worse failures and dissipation of energy. It is with the hope of assisting in stimulating and extending more efficient management in the affairs of towns that attention is directed to these matters and that a list of the minimum accounts and forms necessary is given herewith:

1. Weekly timebook.
2. Daily distribution of labor to the different kinds of work. (Carbons to be kept of this so that the superintendent in charge of the work and the board of government of the town may each have a statement to date of the work being performed. Also if the book is lost, there is a set of records in reserve.)
3. A weekly summary of the daily distribution.
4. A weekly payroll.
5. Teaming slips giving distribution of the work of the teams for the day, which each driver hands to the superintendent each day (Fig. 2).
6. Stock-record slip to give movement of any stock during the day. Since the stock distribution is one of the hardest to keep straight and since it is of the utmost importance in accounting for the expenditure of the public money, this record needs to be kept with great care (Fig. 3).
7. Stockbook, to which items from 6 are transferred.
8. Order-book carried by the superintendent, who for each purchase gives a written order with a carbon copy which he keeps.
9. Voucher checks with distribution items, the same as on the weekly summary and in the account-book (Fig. 1).
10. Account-book, in which are recorded the data from the voucher checks.
11. Notebook (for borrowing money) with numbered pages and record stub so that the authorities will have to account to the auditor for all missing pages in the notebook.

*Chairman, Hanover Precinct Commissioners; Professor of Civil Engineering, Thayer School of Civil Engineering, Dartmouth College, Hanover, N. H.

Owner: Date: 191
Driver: Weather: Hot Cold Muggy Stormy

Time	Work Done	Loads: Number	Loads: Kind of Material	Loads: From	Loads: To
	Total				

FIG. 2. TEAMING SLIP, HANOVER, N. H.
Original, 8⅜x4⅞ in., on white paper, with 12 lines for entries, including total

STOCK RECORD DESCRIPTION	DATE	QUANTITY	TAKEN FROM	TAKEN TO	QUANTITY	USED WHERE

FIG. 3. STOCK RECORD SLIP, HANOVER, N. H.
Original, 7⅛x3⅜ in., on pink paper, with eight entry lines

12. Expenditure record, giving opposite each month the expenditure each year, so that the amount expended in any month of any year or from the first of each month for the remainder of the year will be available in tabular form.

13. Order-book for materials, issued in triplicate.

14. Billing-book for work performed or materials sold, issued in triplicate. (In all cases when duplicates or triplicates are kept, the originals and copies should contain the same printed number.)

With such a system of records and a good superintendent in charge, it will be possible to secure the services of better men as selectmen or commissioners. These men would otherwise be unable to give the time necessary to attain results without which they would not undertake the work.

It is only through keeping adequate records that a proper report can be made to the taxpayers. This report should show at a glance on adjacent facing pages a summary of receipts, disbursements, assets and liabilities in comparison with those of previous years. Between the general statements should be enough detailed accounts arranged in a form to make possible an intelligent study of the affairs of the town by interested parties. At the end of the report should be a budget of estimated expenditures for the next year.

Finally, some standard system of accounting and of superintendence should be adopted so that, as selectmen come and go, the affairs of the municipality shall be kept in the best condition possible.

Measuring Locomotive Coal

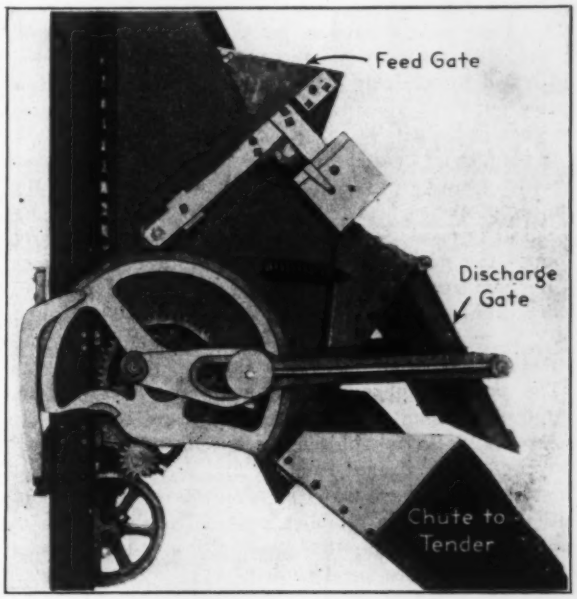
The loading device shown in the accompanying view is for railway coaling stations and is intended to avoid the usual difficulties in the way of keeping close record of the amounts of coal delivered to the various locomotives. It consists essentially of a measuring hopper of one-ton capacity, having a feed gate at one end to admit coal from the elevated storage pocket or bin and at the other end a discharge gate through which the coal is directed into the inclined chute that delivers it to the tender. The two gates are so connected by mechanism that they work in sequence.

The mechanism is operated by a ¾-hp. electric motor, or by means of a hand chain at stations where current is not available. The main shaft makes four revolutions per minute, and with each revolution the measured quantity of 40 cu.ft. of coal (equivalent to one ton) is delivered to the tender.

The locomotive is spotted with its tender under the hinged chute, which the fireman (standing on a platform) lowers by a chain. He then throws the handle of the controller to start the motor. The feed gate, being opened, admits a charge of coal to the measuring hopper and then closes. As soon as it is closed, the discharge gate is opened, allowing the coal to flow to the chute and tender.

As soon as the discharge gate is closed, the feed gate again opens and the operation is repeated, delivering a measured ton of coal every 15 sec. When a sufficient supply has been taken, the fireman throws the controller handle to stop the loader and then raises the chute. This chute has a hooded end, so that the coal drops vertically at the center of the tender.

Record of the amount taken by each engine is effected by means of a counter placed on the coal bin, with figures easily readable from the engine. The fireman marks on his coal ticket the number of his engine (say 152) and the date. When the engine is spotted at the coaling station, he marks the number shown by the indicator on the loading device (say 250). After the tender has been filled, he again notes the number shown (say 257). Thus it is evident that engine No. 152 has taken seven tons of coal. As the first number on each ticket must correspond with the last number on the previous ticket, any attempt to show a lower amount of coal than actually taken would be readily apparent.



MEASURING LOADER FOR RAILWAY COALING STATIONS
Made by the Roberts & Schaefer Co., Chicago

At the coaling station of the Nashville, Chattanooga & St. Louis Ry. new terminals at Cowan, Tenn., all coal is delivered and recorded by four of these loading devices, and during the period Apr. 17 to May 15, 1916, there were 4,623 tons delivered. A test made with one of the loaders showed that 15 tons recorded actually weighed 30,270 lb. on the scales; this is an overweight of only 18 lb. per ton.

This device has been applied at a number of coaling stations. It is known as the Rands measuring coal loader and is built by the Roberts & Schaefer Co., of Chicago.

Strength of Burnettized Timber To Be Studied

By J. M. Barker*

An investigation is being carried out at the Massachusetts Institute of Technology to determine the effect of the Burnett, or zinc-chloride, process of wood preserving on the strength of structural timber. A few results are already available.

It has been suspected for some time that the strength of Burnettized timber is dependent on a number of conditions, chief of which are the strength of the salt solution used, the temperature and humidity of the air in which the timber is placed and the age of the treated piece. It is important also to know the nature of the physical and chemical changes that go on in the cells of the impregnated wood. This investigation has been planned to throw light on these phases of the problem of wood preservation.

Test Specimens and Procedure

The specimens used are selected pieces of North Carolina loblolly pine sapwood, 2x2x30 in. Loblolly sapwood was chosen on account of its susceptibility to the attacks of fungi and its absorptive power. In order to have a basis for comparison, for every stick treated with zinc chloride an untreated piece is set aside to be stored and tested under identical conditions. Impregnation is carried out by immersing the sticks in a cold solution of the chemical until ½ lb. per cu.ft. has been absorbed. Both blanks and treated pieces are stored under a range of constant conditions of temperature and humidity, the number of pieces being such that specimens can be removed at intervals for testing. They are stored in three groups—the first in a room under ordinary conditions of temperature and humidity, the second and third in heater cabinets at constant temperatures of 100° F. and 150° F. respectively. The series of tests is planned to extend over a period of at least three years.

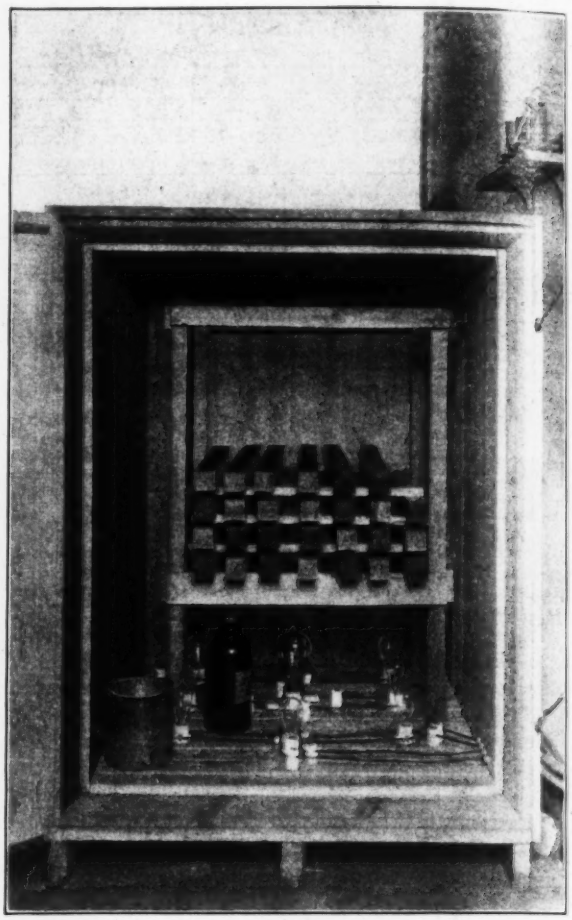
The proposed physical tests are transverse bending, compression along the grain and moisture content. It is proposed also to subject the specimens to chemical and microscopic examination to find out the nature of the changes that have taken place in the cells of the timber. It is hoped to establish general conclusions as to the advantages and limitations of this method of wood preservation in structural timber.

This work was begun in 1915 by A. H. Clarke, a student in the senior class, who studied the general plan of the investigation and devised the apparatus used. In order to try out the method proposed, a preliminary short-time test was run during the spring of 1915, with results that seem sufficiently interesting to warrant brief mention here.

Bending Strength Reduced 17% by Treatment

Ten sticks 2x2x30 in. were cut from the same timber, and five of these were treated. The ten sticks were stored in a cabinet for about forty days at a constant temperature of 150° F. A large pan of water was kept in the cabinet, which gave a humidity of about 13%. The surface of the treated sticks changed gradually to a dull, dark-brown color, which extended into the wood from $\frac{1}{32}$ to $\frac{1}{16}$ in. The ten sticks were tested in cross-bending,

*Massachusetts Institute of Technology, Boston, Mass.



HEATED CABINET FOR STORING SPECIMENS AT TEMPERATURE OF 150° F.

with the result that the modulus of rupture of the treated specimens was less in every case than that of the blanks, the average being 17% less. The moisture content of these specimens was about 2%.

In considering the results of tests on such specimens as these, it must be kept in mind that they are of small size and have much more surface per unit volume than do large pieces. For example, a 12x12 in. by 15 ft. stick has only one-sixth as much area per cubic unit as the test specimen. It seems probable that the weakening takes place near the surface for the most part, and therefore it might be expected that the effect on large pieces is not as severe proportionally as on these small ones. It is hoped to gain more complete data regarding this point by tests on large specimens.

Saturated Solution Destroys the Wood

An idea of the powerful destructive effect of zinc chloride in concentrated solutions may be had from the results of an experiment with miniature specimens. Several pieces of the same timber cut into sticks ¼x½x7½ in. were placed upright with their ends in a saturated solution of the chemical and left in the cabinet at 150° F. for seven days. At the end of that time they looked like pieces of charcoal and had no more strength than that substance.

The tests so far are, of course, a sign post and not a map. They point out that there is a reduction of strength due to the zinc-chloride preservative treatment

when timber so treated is subjected to moderately high temperatures. How much this reduction must be reckoned with in pieces of commercial sizes and how such factors as strength of solution, temperature, humidity and age affect it should become much clearer as the experiments progress.

The need for research of this character was suggested by F. J. Hoxie, Special Inspector for the Associated Factory Mutual Fire Insurance Companies and Special Lecturer at the Massachusetts Institute of Technology, and his advice has been very helpful.

Water-Filled Ashpit on the Baltimore & Ohio R.R.

The terminal improvements of the Baltimore & Ohio R.R. at Chicago include a water-filled double-track ashpit to receive the ashes discharged from the locomotives when cleaning the fires. This is shown in Figs. 1 and 2.

The pit is of reinforced concrete. It is 150 ft. long, 28½ ft. wide over all, with sloping sides and a flat floor 14 ft. wide. Cross-walls on each side, extending as far as the floor, carry a girder consisting of a pair of 20-in. I-beams incased in concrete. The upper part of each side wall is of brick, and the girders rest on brick pedestals on the cross-walls. The brickwork is laid in cement mortar, with alternate headers and stretchers in all courses. The pit is 13 ft. 3½ in. deep.

The two tracks are over the sloping sides of the pit, each track having one rail carried on the side wall and the other on the girder. The rails are 100-lb. per yd., secured by clamps and nuts on anchor bolts.

The 14-ft. central portion of the pit is obstructed only by two cross-girders, which are in line with the first cross-walls at each end and serve to support planks. Thus the ashes can be removed readily by a grab bucket handled by a locomotive crane. These cross-girders are 15-in. channels incased in concrete. The bottom of the pit has

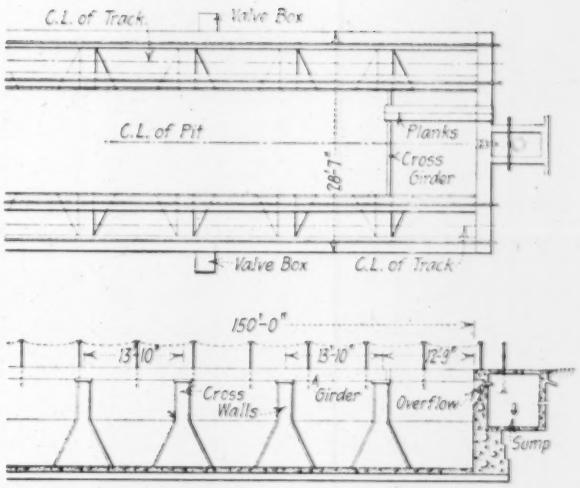


FIG. 2. WATER-FILLED ASHPIT AT CHICAGO

lines of old rails embedded in it to protect the concrete from damage by the grab buckets, and for the same reason the corners of the cross-walls are faced with angles.

Water is supplied by hose from four valve boxes along the sides of the pit. The overflow pipe is about 11 ft. above the bottom. This pipe is placed in one of the end walls and leads into a sump. The ashpit was designed under the direction of F. L. Stuart, Chief Engineer, Baltimore & Ohio R.R. It was installed under the supervision of L. G. Curtis, District Engineer at Chicago.

Water-filled ashpits of the same general type have been built by other railways. The Committee on Buildings of the American Railway Engineering Association, in its report of 1916, shows a pit similar to that of the Baltimore & Ohio R.R., except that the central portion is wide enough (approximately 30 ft.) for a central track carried by girders on a row of piers. This track is for the ash cars, which are loaded by means of a grab bucket handled by an electric gantry crane which spans the three tracks.

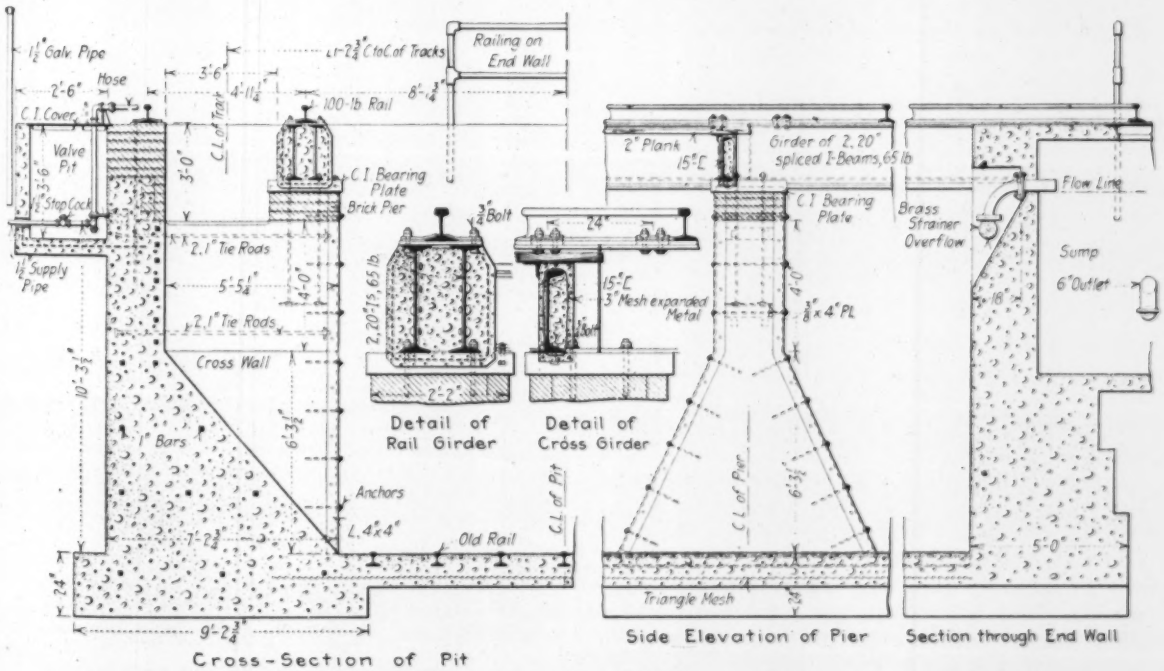


FIG. 1. DETAILS OF CONSTRUCTION OF WATER-FILLED ASHPIT; BALTIMORE & OHIO R.R.

New Trench-Excavation System

SYNOPSIS—Difficult Brooklyn excavation is being handled with horizontal sheeting at large saving. This is made practicable for large excavations by use of narrow trenches for setting the sheeting, and subsequent placing of permanent bracing while core is removed; patented by John F. O'Rourke.

Two difficult pieces of deep trenching are going on in Brooklyn, New York, at the present time with the use of a new system of trenching, or rather a new method of opening sheeted excavations of large size. Horizontal sheeting is used, to eliminate both the disturbance of ground due to driving sheetpiles and the large increase in volume of excavation which is entailed by the stepping out of successive tiers of sheetpiles in deep work. The method is suited to dry ground only.

There are two essential parts to the system; first, the kind of sheeting used, and, second, the procedure of excavating, in which the sheeting is set in narrow trenches dug along the outside of the excavation, and bracing is placed later as the core is removed. The latter is covered by a patent recently granted to John F. O'Rourke, Chief Engineer of the Flinn-O'Rourke Co., on whose work are the two jobs where the method is now employed. Mr. O'Rourke says that the method saved one-third the total excavation on one job and is going to save about one-fourth on the second job; the money saving on the two jobs put together is figured at about $100,000.

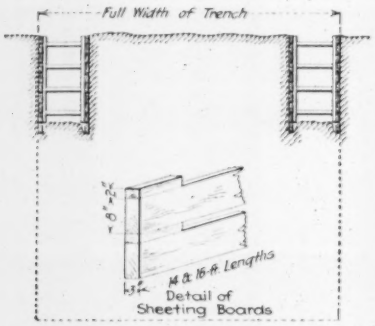


FIG. 1. SKETCH OF SHEETING AND NARROW TRENCH METHOD

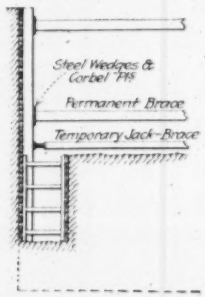


FIG. 2. REMOVING CORE AS TRENCHES GO DOWN

Kind of Sheeting; Spaces for Packing

The sheeting is placed so that spaces are left between the successive sheeting boards, 2 in. wide in vertical direction. Blocks of 2-in. thickness nailed on one edge of each sheeting board, near each end and at intermediate points, form this space.

This form of sheeting was developed in the course of underpinning work at the St. George Hotel, Clark and Hicks St., Brooklyn. The pits sunk under the piers of this tall and heavy building to depths of 75 ft. and over were sheeted horizontally, using at first sheeting of the Breuchaud louver-board type. Later square-edge openings were substituted for the inclined slots in accordance with the sketch, Fig. 1, and the results were found at least as good as with the inclined slot while the preparation of the board was much simpler. The spaces between boards were used for packing earth back of the lowest or last-placed sheeting board, which packing held the ground from running down into the space scooped out for the next sheeting board below.

Excavation of Henry St. Shaft, Clark St. Tunnels

The trench and core method was developed from the favorable experience with horizontal sheeting in avoiding loss of ground. It is a means of applying horizontal sheeting to large and deep excavations in complete security by reducing the operations of placing sheeting to those of sinking a narrow trench, i.e., separating the tasks of sheeting and bracing. The method was first used at a large station-entrance shaft for the Clark St. tunnels, which is being constructed in the lot adjacent to the St. George Hotel and will later be covered by an addition to the hotel.

The shaft is 35x53 ft. and 83 ft. deep. The whole depth is in sand containing boulders and similar obstacles. To excavate the shaft by the use of driven sheeting (5 tiers) would have made the top about 15 ft. larger in each direction and thereby would have increased the total excavation of 5,200 cu.yd. by 2,550 cu.yd. of useless excavation; besides several nearby parts of the hotel buildings would have had to be taken down. All these difficulties were avoided by the use of horizontal sheeting.

Objection was made by the owners of the lot to any method of construction which would leave timber in the ground to decay and cause future settlement. The contractors satisfied this objection by placing grout and mortar packing behind the sheeting. The space for a

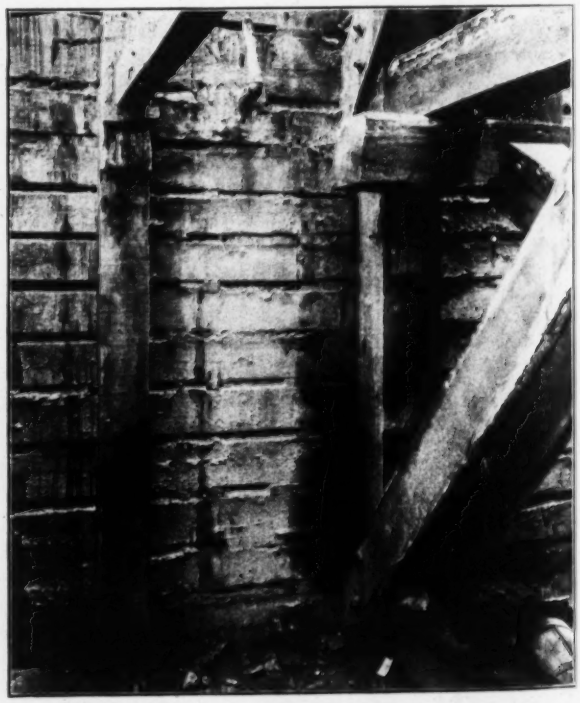


FIG. 3. CEMENT-BACKED SHEETING OF HENRY ST. SHAFT IN BROOKLYN

FIG. 4. VIEW UP HENRY ST. SHAFT
Sunk by narrow-trench method. All sheeting horizontal. Transverse braces through; longitudinal braces cut in

sheeting board was dug out 4 in. back of the outer line of the sheeting, so that when the board was placed, lined up plumb and held by bracing in front, there was a 4-in. space behind it. This space was at once filled by pouring in grout and finally keying up with stiffer mortar. By the time the board next below had to be placed, the grout and mortar were already set hard and formed a satisfactory dam to prevent material running down when clearing the space below.

The trench wall thus formed consists of the 3-in. sheeting and the 4-in. thickness of concrete outside, bonded into the spaces between the boards. As the permanent lining concrete of the shaft will be placed directly against the inside of the sheeting boards, the boards finally will be completely incased in concrete. After the decay of the boards there will be narrow spaces left in the concrete something like the openings in hollow tile. It is considered that this method of construction will obviate all settlement.

The shaft excavation was carried down entirely by the narrow-trench method, working around the four sides of the excavation simultaneously. Figs. 1 and 2 illustrate the essential steps. In Fig. 1 is a sketch showing the trenches sunk for placing the sheeting, and Fig. 2 shows the operation of taking out the core and putting in the bracing. The trenches were kept about 10 ft. below the bottom of the general excavation. Setting the main system of bracing for the shaft as a whole proceeded above while trench work was going on below. The sheeting boards of the inner faces of the trenches after they were removed were dropped to the bottom of the trenches and there used in carrying down the sheeting.

The section of the shaft (Fig. 6) shows the timbering as originally sketched out. As actually built, there are no horizontal rangers along the wall but the transverse braces butt directly against the vertical rangers. The transverse braces are continuous and the longitudinal braces are cut in between them. At the outer ends of all braces 14-in. square packing plates in pairs, with iron wedges between, are used to enable the braces to be tightened. There is also some diagonal bracing in the horizontal plane in the panel adjacent to the outside, to brace intermediate vertical rangers of the sheeting, and there is a small amount of vertical diagonal bracing and kneebracing not shown in the section.

60-Ft. Trench for Subway in Fulton St., Brooklyn

More extensive use is made of the method in the Fulton St. open-cut subway work. Here the method is applied in its normal manner, without mortar packing. The Old Slip-Clark St. tunnels pass into open-cut subway construction in Fulton St. at Pierpont and soon afterward cross over the South Ferry-Montague St. pair of

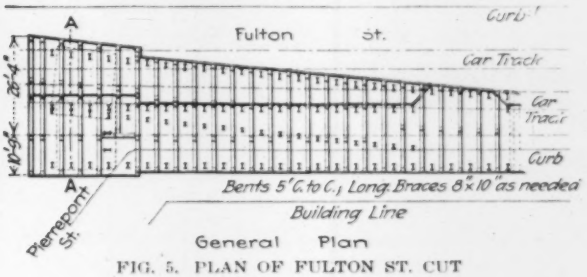


FIG. 5. PLAN OF FULTON ST. CUT

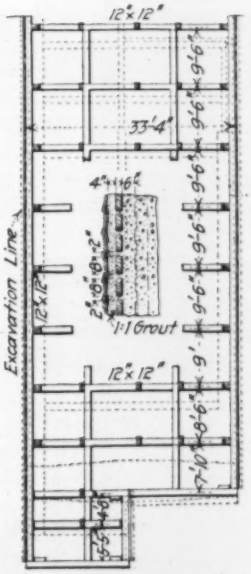


FIG. 6. SECTION OF HENRY ST. SHAFT

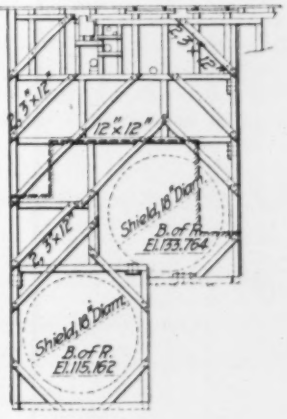

12"x12"
Shield, 18' Diam.
B. of R. El. 133.764
Shield, 18' Diam.
B. of R. El. 115.162
Section at Shield Chamber Fulton St. Cut (Section A-A of Plan)

FIG. 7. SECTION OF FULTON ST. CUT

tunnels. In this region the street excavation is about 60 ft. deep. All of it is being taken out by the narrow-trench method. The side trenches as used here are about 5 ft. wide inside of rangers. The sheeting used is 3x6, with 2-in. blocks as described before. The excavation is in slightly coherent sand, and only in a few places is outside earth being brought in for packing behind the sheeting through the spaces between boards. The material is generally firm enough so that the bottom of the trench can be shoveled down to a foot or more below the lowest sheeting board and thus the operation of clearing ground for the next sheeting board and placing this board considerably simplified.

The temporary ranger system in the narrow trenches is put in piecemeal as temporary blocking, board by board, and after five or six boards are set the regular system of temporary rangers placed. The trench is

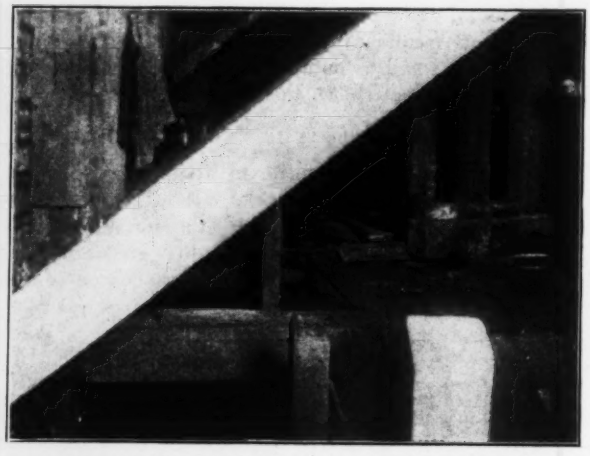


FIG. 8. NORTH WALL OF FULTON ST. CUT

Main excavation about 25 ft. below street planking. Sheeting trench 18 ft. lower, to go to 20-ft. depth along side shield-dismantling chamber. The heavy horizontal timbers are 12x12 transverse through braces at level of roof of shield chamber.

kept about 10 ft. below the general excavation level and this allows for extending the permanent 12x12 bracing rangers in full sections.

At the western end of the excavation, where a chamber for dismantling the shields of the tunnel is formed in the timbering, the arrangement of bracing is as shown in the lower part of the section. Here the side trenches have to be carried down the full 20-ft. height of the shield chamber, so that the permanent rangers in this height can be set in a single piece in order to form a rigid frame when the kneebracing is put in. The bracing of this section throughout is so arranged as to give rigidity and strength even in case of local settlements or failure of supports.

Figures on Saving of Excavation

The saving of 2,500 cu.yd. of excavation in the Henry St. shaft has already been mentioned. The Fulton St. cut contains a pay volume of 45,000 cu.yd. of excavation. With three tiers of vertical sheeting (20-ft. tiers) there would have been 14,000 cu.yd. additional to be excavated outside the pay line. All this additional excavation is saved by the horizontal-sheeting method. Mr. O'Rourke estimates that the saving to his company on the Henry St. shaft was at least $25,000, and that there is likely to be three times as great a saving in the Fulton St. cut.

The method was patented Apr. 18, 1916 [illegible] 1,179,750). The patent covers not only the application of the narrow trench method as here described, but also its use in cases of very wide excavations where it is not desired to extend the bracing across the excavation but instead to brace by rakers. It provides for placing the sheeting with only the complication incidental to temporary bracing of the narrow trench and putting in permanent bracing afterward as a second and separate operation. A typical claim of the patent is as follows:

The method of producing an excavation consisting in making spaced trenches, bracing the outer walls of such trenches against the inner walls thereof, excavating material between said trenches for the desired excavation and bracing the outer walls of said excavation together.

The inventor has also just made an unusual offer to contractors, namely, to allow any contractor the free use of the method on half of any job he may be doing where it is suitable; if he then desires to use it for the other half of the job he may obtain a license therefor on paying one-quarter of the reasonable saving of cost secured by the method.

The Applicant's Difficulty

By R. Fleming*

It may be inferred that the writer of a letter making application for a position will express himself at his best. An analysis of 493 letters written during the years 1914 and 1915, applying for engineering positions, gives some interesting results. Of these letters 217 were from college men, either graduates or members of graduating classes. Fifty colleges were represented. Only about one letter in three from these college men could be called "good," and hardly one in twenty would receive special attention. In fact, the applications of two men stating "I am not a college man" and some letters from boys wanting to be tracers made a more favorable impression than those from the majority of college graduates.

What are some faults in their letters? In the first place, 95 out of the 217 were on notepaper. A favorite-sized page was 5x6 in. There is a semblance of authority for the use of notepaper in at least one handbook, but the advice of a professor to his senior class might well be followed:

When you write a letter applying for a position, use business paper and not love-letter stationery, for a business letter is not a love letter.

Notepaper is inconvenient for filing. What engineer has not had personal experience with applications "filed for future reference"?

Poor Handwriting and Spelling

Careless handwriting is another common fault. Fine penmanship is not vouchsafed to many, but the writing of everyone can be at least legible. A consulting engineer writes in such a slovenly manner that his letter is hard to read. He may have thought that his letterhead would do away with the necessity of writing distinctly. It is often difficult to read the name at the end of a letter. An associate professor of drawing wants a salary of $40 a week, but one can only guess his name. The same is true of a candidate "for a responsible position."

*American Bridge Co., 30 Church St., New York City.

A graduate of an institution like . . . should not be a "beginer," nor should a graduate of . . . be "thankfull." Perhaps the man who writes "weather," "imaterial" and "having had ample technical education to warrant a drauftsman's position" is not a college graduate.

Many applications give too little definite information. Such statements as "I am a college man," "I am a graduate from an engineering school," "have a fine technical education, being a college graduate," "am technically educated," could be better expressed by giving the name of the college and the year of graduation.

Serious Faults of Style

A flippant tone in a letter is not conducive to its favorable reception. One man writes:

> However, it is not my intention in submitting same, that it be placed on file for some future manager to cast into the wicker morgue, because sir I graduate from the Civil Engineering Course of . . . the coming June, and the position for which I am making application can be filled at that time.

A bombastic or too confident tone is not to be commended. The man who writes:

> Have had 13 years' experience in structural drafting. . . . Have never made an expensive error in any work I have turned out. . . .

may never have had much responsibility thrown upon him.

The following letter is unclassified:

> I am a young man (19). I have received a 4 year Civil Engineering Education and a year of Field Experience I am fully versed in designing and constructing steel structures, Reinforced Concrete, also numerous other things in the Engineering line.

An irreverent hand had written in pencil, "Some boy!"

Sypherd, in his "Handbook of English for Engineers," summarizes weak points in letters of application under: Poor Beginning, Faulty Sentence Structure, Excessive Use of the First Person, Excessive Modesty and Miscellaneous Errors. He gives the advice:

> Begin at once without any preliminary explanation with a statement of what you desire; say briefly, straightforwardly and without assuming too great knowledge or skill, whatever you think your future employer ought to know about what you have done or can do; refer him to men who can speak definitely and without reservations as to your ability and moral worth; then stop.

It should be noticed that no letter of application, however well written, will secure a position unless there is one to be had. For the last two or three years the bread line of engineers has been a long one. That the supply still exceeds the demand becomes evident by comparing the "Positions Wanted" with the "Positions Vacant" in the advertising columns of the technical papers. There are applicants by the score for every position vacant. The importance of the letter of application is apparent. This, however, is but one phase of a larger subject—the use of better English by engineers.

Schools Trying To Meet the Difficulty

In his preliminary analysis[1] of the replies received from 23,000 circular letters to engineers regarding the needs of the profession Professor Mann, of the Carnegie Foundation for the Advancement of Teaching, writes:

> In questioning the efficiency of the engineering schools at the present time there are four conspicuous things in which the professional men show a fair degree of unanimity. The first and most important is English. A large majority of the letters received mention the absolute necessity for higher efficiency in the training in English.

Some colleges are trying to meet this need. The Stevens Institute of Technology in its catalog for 1916-17 states: "No effort is spared to impress upon the students that their success as engineers will depend largely upon their knowledge and use of language." Attention is given to English and Logic throughout the college course. This seems more rational than to neglect them, claiming that these particular branches belong to the grammar and high schools. Where English is neglected because the course is already overcrowded with other subjects, something might be done by way of substitution. Often out-of-term and supplemental-reading courses could profitably be introduced.

In conclusion attention is called to the following books on the subject:

"Handbook of Composition," Wooley. This is an excellent manual on general composition.

"Handbook of English for Engineers," Sypherd. This should be studied by every engineer called upon to do business or technical writing.

"Engineering as a Vocation," McCullough. The six chapters of this book can be read with profit by every young engineer, especially Chap. V—"How to Hunt and Hold a Job."

"The Theory and Practice of Technical Writing," Earle, and "Good Engineering Literature," Frost, are of value to the engineer given to writing for the technical press.

[1] Bulletin of the Society for the Promotion of Engineering Education, Vol. VI, p. 100 (October, 1915).

Unit Cost Figures on Illinois State-Aid Roads

Between July 1, 1914, and Jan. 1, 1915, contracts were awarded for the construction of state-aid roads in Illinois on 74 different sections, with an aggregate length of 91.27 mi. The total contract price of the work was $1,116,952, or an average of $12,240 per mile of completed road. From Jan. 1 to June 30, 1915, additional contracts were let amounting to $466,271. An analysis of the cost of these roads by M. W. Watson, Assistant Engineer of the State Highway Department, was published in *Illinois Highways* for March-April.

The earthwork on the roads was comparatively light, averaging about 5,550 cu.yd. per mi., and the average cost of handling it was 28.9c. per cu.yd. An analysis of the prices of 50,000 lin.ft. of 10-ft, concrete roads shows that the price per square yard of pavement varied from $1.03 to $1.41, and averaged $1.21. On 64,000 lin.ft. of 15-ft. concrete roads, the contract price for the pavement proper varied from 92c. to $1.21 per sq.yd. and averaged $1.11. On 35,000 ft. of 18-ft. concrete roads, the price per square yard of pavement varied from $1.03 to $1.27, and averaged $1.20. On 21,000 ft. of 10-ft. brick roads the price per square yard varied from $1.65 to $2.05, and the average was $1.88. On 19,000 ft. of 18-ft. brick roads the price per square yard of pavement varied from $1.63 to $2.37, with an average of $1.85. The cost of macadam shoulders for concrete and brick roads varied from 39c. to 52c. per sq.yd. The cost of 7520 ft. of macadam roads averaged 51c. per sq.yd. of pavement. The cost of 27,806 ft. of gravel roads averaged 43c. per sq.yd. of pavement.

Field and Office

Winter Sewer Work at St. Paul

By George H. Herrold*

An unusually wet season in 1915 and the prospects of a large amount of work in 1916 induced Thornton Brothers Co., St. Paul, Minn., to give a thorough tryout to open-trench sewer work in winter weather. This firm was awarded the contract for the Snelling-Como sewer system by the City of St. Paul for $263,000. It signed the contract on Nov. 9, 1915, and immediately began moving its outfit on the job.

The system consists of approximately 13 mi. of mains and laterals. The main system consists of 3,196 ft. of 75-in. monolithic concrete sewer, 2,953 ft. of 66-in., 3,009 ft. of 54-in. and 1,354 ft. of 36-in. vitrified segment blocks; there are 11 mi. of 9- to 30-in. laterals.

The contract equipment consisted of two steam shovels, ⅞-yd. dipper, one Buckeye trenching machine, one Carson conveyor, two White bucket machines, 12 dump cars, a mile of narrow-gage track, 20 dump wagons, three gasoline trench fillers and a camp equipment for housing and feeding 175 men. The bunk house and dining room are equipped with electric light and city water.

The entire district drained by this system, which adjoins the State Fair grounds, is underlain with sand and gravel with an earth cap 2 to 4 ft. thick. Sheeting has been used on every foot of the work except about 600 ft. of the 11 mi. of laterals, all from 11 to 30 ft. deep. The ground was thawed by fires, using Illinois washed nut coal and some hardwood; the thawing crews worked nights. All of the laterals, 250 manholes, the 1,354 ft. of 36-in., 3,009 ft. of 54-in. and 750 ft. of 66-in. main were completed May 1, 1916.

Weather conditions were quite severe. During November, 4.7 in. of snow fell; in December, 6 in.; in January, 20.5 in., and in February, 4.5 in. There was no severely cold weather until after Jan. 1; that is, none below zero, but the light snowfall was little protection even in slightly freezing weather. On Dec. 15 there was a foot of frost

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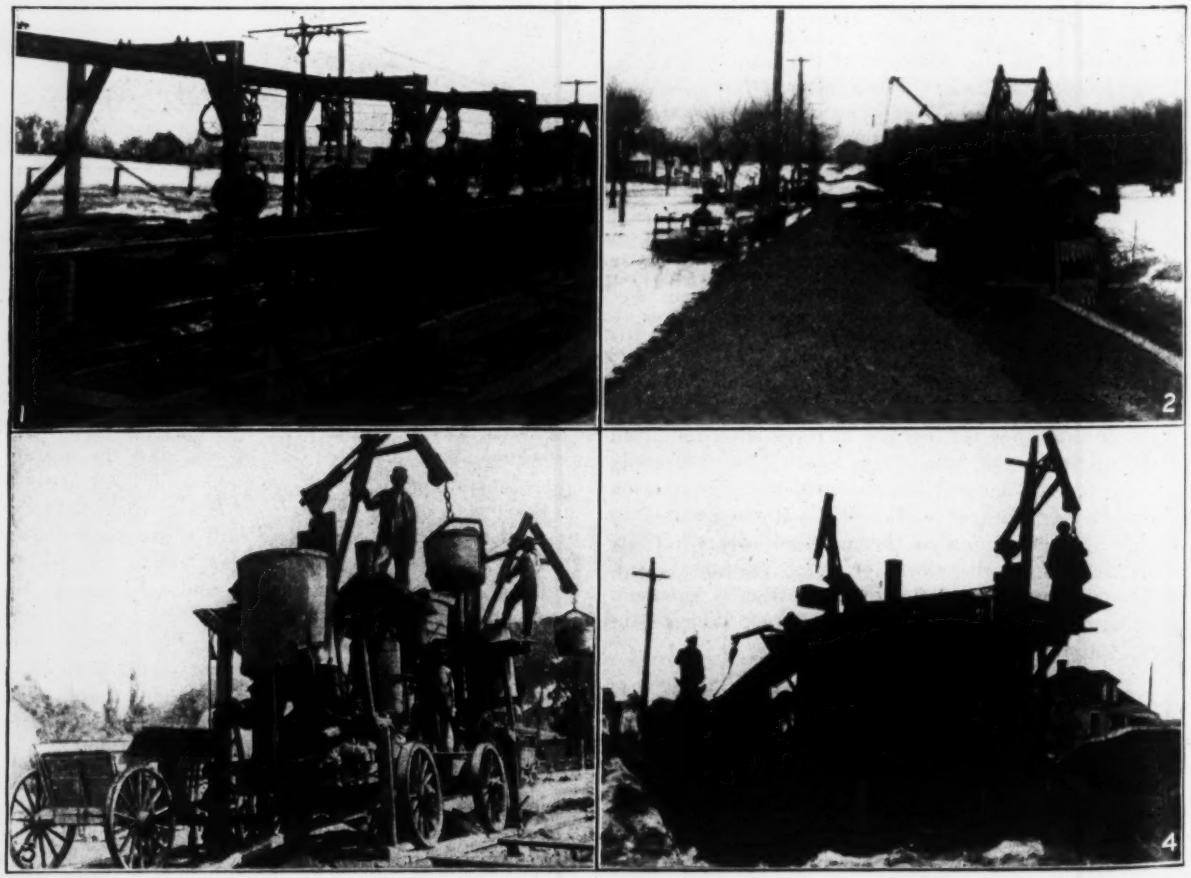

DIGGING SEWER TRENCHES IN ST. PAUL AFTER THAWING FROZEN GROUND

Fig. 1—Carson conveyor machine backfilling over 54-in. sewer. Fig. 2—Buckeye trenching machine on a lateral. Fig. 3—White trenching machine, with drop-bottom buckets on swinging crane to hold spoil. Fig. 4—White machine with chutes replacing buckets to reduce weight on trench side.

to work through, and the contractors began thawing out the ground with fires. In January there were 16 days of below-zero weather, the lowest temperature being —31° F., and in February, 12 days, the lowest being —20°. Frost reached a depth of about 5 ft. Jan. 10. The snow was removed from the ground over the line of the trench by means of ordinary road graders.

The frost was taken out by starting a coal fire about half the width of the trench—in the case of small trenches—and 100 to 300 ft. in length. After the fires were well under way they were covered with semicircular corrugated iron strips to hold the heat to the ground. When the fires burned out the thawed material was picked out and another fire started in the bottom of the trench. The thawing proceeded until the gravel was reached.

For the large trenches three lines of fire were placed, one each at the outer edge of the trench and one down the center. A steam shovel mounted on heavy timbers spanning the three small trenches then broke out the cakes of frozen earth between them and continued digging in the gravel. Sheeting crews had to work between the dipper and the timbers that supported the steam shovel, driving 16-ft. lengths while the shovel excavated 10 to 12 ft. deep. The shovels were followed by the Carson conveyor or a White bucket machine completing the trench, another line of sheeting being driven inside the first as the trench was deepened.

The Carson machine was used on the 3,009 ft. of 54-in. sewer. Work was started on Dec. 7 and finished on Mar. 1. The depth of the trench for this sewer was from 15 to 31 ft. The machine consists essentially of a steam hoisting machine in a housing on wheels, following as close to the steam shovel as practical. It operates an overhead cableway on a rectangular framework supported on rails laid along each side of the trench, carrying 24 buckets, six in each set. While six buckets are in the trench being filled six are on the way to be unloaded, six are being unloaded and six are returning empty. The sewer is laid in the trench and the backfilling is made with these buckets from the excavation taken out in front of the pipelaying.

The White machine is a double-bucket hoist and will dig a trench 48 ft. long without moving. The bucket is raised and emptied into dump cars or dump wagons, and the spoil is hauled back to be used as cover for the completed sewer. It handles about 150 cu.yd. a day.

The Buckeye trenching machine digs to a depth of 14 ft. It dug 400 to 600 lin.ft. of trench a day. It was used wholly on laterals. Frost was thawed to a depth of 2.5 ft. ahead of the machine and 2½ ft. of frost was cut out with the machine.

The cost of thawing ran from 15 to 25c. per lin.ft. of fire.

The work has been very satisfactory from an economical standpoint for the contractors and very acceptable to the engineering department of the city. The contractor has had a full camp and no labor troubles and less delay from weather conditions than are ordinarily met.

Drainage-Ditch Design Tables

Hydraulic tables for use in designing systems of drainage ditches have been prepared by John C. Burke, civil engineer, of Bemidji, Minn., who sends the example shown herewith. The tables have been found very convenient in the rapid checking of ditch dimensions and the control of velocity. Quantities for Elliott's formula and for two coefficients of Kutter's formula are given to afford ready comparison with other designs.

The figures at the right, giving the cubic yards of excavation per mile of ditch of given size, serve as a useful check on selected sizes and grades with regard to economy in first cost of system.

HYDRAULIC TABLES FOR DRAINAGE-DITCH WORK

Base	Depth	Top	Wet Area	Wet Perimeter	Hyd. Radius	Grade, %	Velocity, Kutter's 0.025	Velocity, Kutter's 0.030	Discharge, Sec.-Ft. 0.025	Discharge, Sec.-Ft. 0.030	Cu. Yd. per Mi.
4	3	10	21	12.5	1.7	0.02	1.2	1.0	24	21	4,107
..	..	..	..	..	..	0.04	1.7	1.3	46	37	
..	..	..	..	..	..	0.06	2.1	1.7	54	44	
..	..	..	..	..	..	0.08	2.4	1.9	64	50	
..	..	..	..	..	..	0.10	2.7	2.2	77	57	
4	4	12	32	15.3	2.1	0.02	1.4	1.1	58	45	6,258
..	..	..	..	..	..	0.04	1.9	1.6	82	61	
..	..	..	..	..	..	0.06	2.4	1.9	98	77	
..	..	..	..	..	..	0.08	2.8	2.2	114	90	
..	..	..	..	..	..	0.10	3.2	2.5	130	102	
4	5	14	45	18.2	2.5	0.02	1.5	1.3	90	68	8,800
..	..	..	..	..	..	0.04	2.2	1.8	130	99	
..	..	..	..	..	..	0.06	2.8	2.2	160	126	
..	..	..	..	..	..	0.08	3.2	2.5	180	144	
..	..	..	..	..	..	0.10	3.5	2.8	200	156	
4	6	16	60	21.0	2.9	0.02	1.7	1.4	130	102	11,740
..	..	..	..	..	..	0.04	2.4	2.0	180	144	
..	..	..	..	..	..	0.06	3.0	2.5	220	180	
..	..	..	..	..	..	0.08	3.4	2.8	255	204	
..	..	..	..	..	..	0.10	3.9	3.2	285	234	
4	7	18	77	23.0	3.2	0.02	1.8	1.5	175	139	15,080
..	..	..	..	..	..	0.04	2.6	2.2	240	200	
..	..	..	..	..	..	0.06	3.2	2.6	300	246	
..	..	..	..	..	..	0.08	3.7	3.0	350	285	
..	..	..	..	..	..	0.10	4.1	3.3	390	316	
4	8	20	96	26.6	3.6	0.02	2.0	1.7	225	192	18,780
..	..	..	..	..	..	0.04	2.8	2.4	320	269	
..	..	..	..	..	..	0.06	3.5	2.9	390	336	
..	..	..	..	..	..	0.08	4.0	3.3	450	384	
..	..	..	..	..	..	0.10	4.5	3.7	508	432	
4	9	22	117	29.4	4.0	0.02	2.2	1.8	293	257	22,890
..	..	..	..	....	...	0.04	3.1	2.5	415	363	
..	..	..	..	....	...	0.06	3.8	3.1	510	444	
..	..	..	..	....	...	0.08	4.4	3.5	590	514	
..	..	..	..	....	...	0.10	4.9	4.0	660	573	

Ruptured Floor-Beam Stirrup Drops Bridge Floor

An unusual and somewhat obscure accident to a steel highway bridge is recorded in the January-February issue of *Illinois Highways*, the bulletin of the State Highway Department. Two panels of the floor of a truss bridge over the Spoon River in Persifer Township, Knox County, fell by fracture of one of the stirrup floor-beam hangers, while a traction engine was crossing the bridge. The engine, said to have weighed 12 tons, was pulling a tank wagon and a corn sheller, and apparently these loads were so grouped over the two failed panels, at the moment of failure, as to give something near maximum floor-beam reaction. The county highway superintendent says, as to circumstances and cause:

> **The temperature was about 10° above zero and the river was covered with about 6 in. of ice. The bridge, which had been repaired and painted three years ago, was supposedly in good shape. This same engine had crossed it several times before. It is presumed that the cold weather had weakened the stirrup to such an extent that it snapped when the sudden strain, caused by the weight of the engine, came upon it.**

While the above cold-weather explanation of the failure cannot be accepted, no satisfactory explanation is possible in the absence of details of the ruptured hanger.

The bridge was built in 1898, at a time when there was no state supervision of highway bridge construction in Illinois. Under these circumstances, and with floor suspended by U-stirrups, the bridge was probably not free from local overstress due to secondary bending. Such overstress in the stirrup might result in rupture under a load which had previously been carried in safety, as happens in old chains and other highly-stressed working parts.